JOINT INDUSTRY PROJECT ON HUMAN FACTORS

IN OFFSHORE OPERATIONS

APPENDIX D

ROLE EVALUATION TOOL

EQE INTERNATIONAL LIMITED
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1	14/5/97	M. Jennings Senior Engineer	Mike Hogan Principal Engineer	Mike Hogan Principal Engineer for S.J. Lewis Director

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CONTENTS

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

INTRODUCTION

The Role Evaluation Tool (RET) represents the first step in an overall approach to performing human factors assessments. The RET defines a work role in terms of human factors to enable a qualitative assessment to be made of those factors which can impair role performance. The RET therefore provides a qualitative assessment of the potential for human failure as a result of identified human factors. The full scope of human factors are considered, ie psychological, physiological and physical factors. Such factors include those associated with limitations of human mental processes, physiological responses to the environment, and human physical limitations.

The RET can be utilised in a number of ways, from an inspection made by an individual, where it is used as a checklist and reference guide, to a detailed assessment of a work role made by an assessment team. To perform the latter, an assessment team comprising at least two individuals who currently perform the role being evaluated (ideally one of which should be an individual who has performed the role for 10 years or more), a supervisor to the role, and a safety adviser, work through and respond to the questions as given under A1 (Role Characteristics) and B1 (Role Requirements). Where a role involves performing tasks in different environments, then each environment needs to be considered separately under A.1. The responses to these questions are then reviewed against the information and guidance given in A2 (Human Characteristics) and B2 (Human Requirements) which detail how each human factor can affect an individual.

The potential for human failure exists when a response to a particular question in sections A1 or B1 is not consistent with the information and guidance given under that question in section A2 or B2; or the text identifies the very presence of a particular factor can impair human performance.

Having identified a potential for human failure there then exists the requirement to investigate the particular factor or factors which the RET highlights as a problem. The actual investigation undertaken will depend greatly on the objectives of the assessment, and could range from an investigation to determine possible design, practice or procedure changes to minimise the potential for human failure; an investigation to determine selection and/or training requirements for potential role holders; or an investigation to determine a subjective or quantitative estimate of human failure probability where human failure potential is unavoidable (see uses).

Those investigations which aim to determine selection and/or training requirements for potential role holders or a quantitative estimate of human failure probability can necessitate psychological, physiological and/or physical testing of an individual or individuals. Advice on the generation of such tests or the selection of commercial tests should be sought from a human factors specialist. Analysing the human factors in this manner will provide a means to gain a more detailed insight into the effect such factors have on an individual's performance in the work role, investigate the interaction of factors, ensure that individual performance and competency assessments are performed in an appropriate manner, and where the testing is performed on a number of individuals, provide industry specific frequency data on human failure for input to quantitative human error probability and risk assessment techniques.

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

INTRODUCTION

The RET can be used on a range of work roles. Where safety critical roles and tasks have been identified, the RET can be used to assess the potential for human failure in such roles.

Definitions

The RET contains a number of terms which require definition. These definitions are as follows:

Psychological factors:	associated with human mental processes, for example, perception, memory, and attention.
Physiological factors:	associated with the (non mental) processes of the human body, for example thermoregulation, and heart rate.
Physical factors:	associated with the human body or physical matter, for example muscle build, and physical environment.
Role:	the work role an individual performs, for example Chef, Technician, Control Room Operator, Offshore Installation Manager. The role includes all tasks the role holder performs. This is also the case where a role involves multi-tasks, such as Operations and Maintenance Technician.
Human Failure:	all possible failures of the human mind and body. For example mental error, disease, and muscle or skeletal (musculo-skeletal) injury.
Safety Critical tasks:	tasks which if not performed successfully could result in serious injury, fatality, loss of containment, or major damage to an installation or the environment.

Uses of the RET

The RET has a number of uses. In particular, the RET:

- provides a consolidated, holistic approach to assessing human factors, and identifies many of the human factors which can impair performance and increase the potential for human failure,
- provides information on the effects of the role and the working environment on an individual's health and performance,
- optimises a role and the working environment to align with human capabilities,
- provides information for specifying competence assessment programmes,
- assists in the identification of training needs,
- assists in the setting of standards for measuring and managing work performance,
- and, assists in the investigation of incidents.

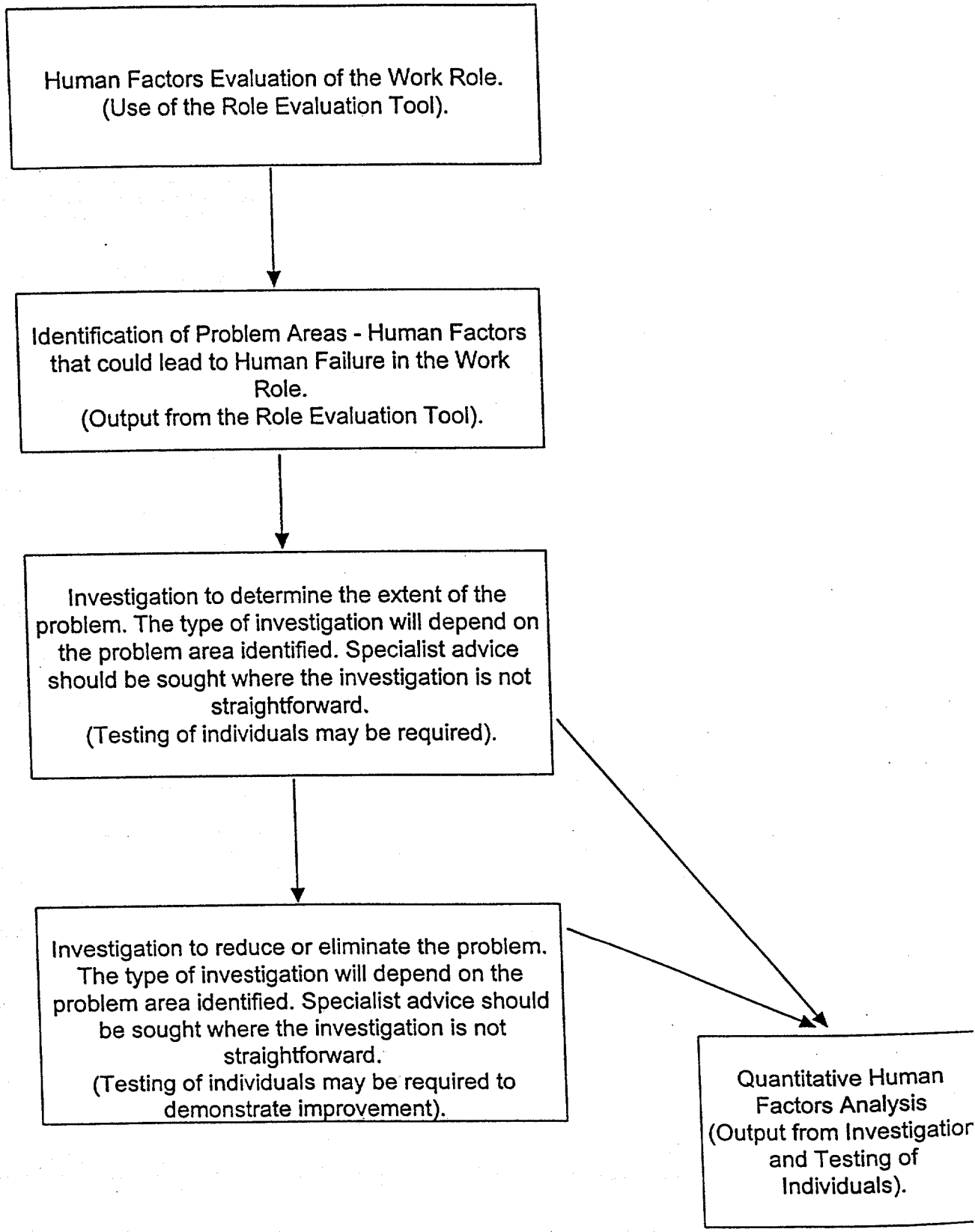
INTRODUCTION

Legislation and the RET

Application of the RET and subsequent investigation(s) outcomes etc. should take into account, and be in accordance with, all applicable legislation (and company policies) that exist at the time.

The RET only references certain legislation where it provides additional information on performance impairment as a result of human failure for a particular factor in Sections A.2. and B.2. and should not, therefore, be considered as providing a total index of applicable legislation.

OVERALL APPROACH TO HUMAN FACTORS ASSESSMENTS USING THE RET



ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

A1. ROLE CHARACTERISTICS

The Role Characteristics are defined as the properties of the Role as opposed to the requirements of the Role. These properties can be as a result of the physical and personnel environment (culture and sub-culture) in which the Role is performed, hazards that exist as a result of the environment or as a result of the tasks performed within the Role, the Organisation which supports the Role, and the fact that the role is performed by humans who have variable qualities.

A1.1	Define the physical environment in which the role will be performed in terms of ambient temperature. What is the variation in this temperature. What are the extremes in terms of maximum and minimum temperature?
A1.2	Define the physical environment in which the role will be performed in terms of ambient radiative heat temperature. What is the variation in this temperature? What are the extremes in terms of the maximum and minimum radiative heat temperature?
A1.3	Define the physical environment in which the role will be performed in terms of vibration. What is the variation in this vibration? What are the extremes in terms of the maximum and minimum vibration?
A1.4	Define the physical environment in which the role will be performed in terms of surrounding ambient pressure. What is the variation in this pressure over short and long periods? What are the extremes in terms of the maximum and minimum ambient pressure?
A1.5	Define the physical environment in which the role will be performed in terms of noise level (continuous and intermittent), i.e. undesired sound. What is the variation is this noise level? What are the extremes in terms of the maximum and minimum noise level? What are the noise sources?
A1.6	Define the physical environment in which the role will be performed in terms of air pollutants that might be present (continuous or intermittent). What is the variation in air pollutants and their maximum and minimum concentration in the atmosphere?
A1.7	Define the physical environment in which the role will be performed in terms of relative humidity. What is the variation in relative humidity? What are the extremes in terms of the maximum and minimum relative humidity? Is the relative humidity controllable, and, if so, what factors determine the set level?

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

A1. ROLE CHARACTERISTICS

A1.8	Define the physical environment in which the role is to be performed in terms of air movement (speed and rate of change in an enclosed environment). What are the maximum and minimum values?
A1.9 (a)	Is the ambient lighting natural and/or artificial? What is the ambient lighting level, does this vary throughout a 24 hour period according to a set pattern? Can the lighting level be varied manually?
A1.9 (b)	What is the main colour scheme of the environment?
A1.10	Will performing the role cause an adverse change to any of the above environmental factors? If so, how and to what extent?
A1.11	Is the environment in which the role is performed stimulating or monotonous?
A1.12	Is the role performed under extreme changes in environmental conditions?
A1.13	Define the type and extent of distractions and interruptions that might be expected from the environment.
A1.14	Define the environment in terms of potential chemical hazards.
A1.15	Define the environment in terms of potential physical hazards.
A1.16	Define the environment in terms of potential biological hazards.
A1.17	What are the potential chemical hazards that are introduced as a result of performing the role
A1.18	What are the potential physical hazards that are introduced as a result of performing the role?
A1.19	What are the potential biological hazards that are introduced as a result of performing the role?
A1.20	Define the workstation/site in which the role is performed in terms dimensions and layout? Who or what determined the dimensions and layout? If the workstation/site is designed for human activity, is there a design standard?

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

A1. ROLE CHARACTERISTICS

A1.20 Contd.	Can the workstation/site be adjusted to suit different individuals of different dimensions?
A1.21	Where is the workstation/site located, e.g. at height, over the side of the platform, within a confined, enclosed or congested space?
A1.22	Are other activities outwith those associated with the role carried out at the same workstation/site?
A1.23	What is the duty pattern associated with the role (i.e. what is the minimum, average and maximum number of hours one person might be expected to be on duty in a 24 hour period and how many days would such a duty extend)?
A1.24	Is the role performed by more than one person to give continuous attendance with respect to time? If so, define the resultant shift schedule associated with the role? The following terminology has been used in the questions given under A1.24: shift — the time of day on a given day that a role holder is scheduled to be at the workstation/site, off time — hours not normally required to be at the workstation/site, schedule — sequence of consecutive shifts and off time, permanent hours — schedule that does not require the role holder to work more than one shift (the time of day worked is constant), rotating hours — schedule that requires the role holder to work more than one shift (the time of day worked changes), basic sequence — minimum number of days of shift and off days until a sequence begins to repeat. What is the basic sequence of the shift schedule? What is the normal total number of hours within each shift? What is the maximum total number of hours within each shift? What are the times of each shift in the shift schedule?

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

A1. ROLE CHARACTERISTICS

A1.24 Contd.	What is the normal number of consecutive shifts in a schedule? What is the maximum number of consecutive shifts in a schedule? What is the minimum, average and maximum total number of hours on shift in any preceding week ? Is the shift pattern irregular? Is there a changeover within the shift schedule, e.g. days to nights or vice versa. and how is it performed? What are the shift handover times and duration, and how is this performed? What is the maximum number of hours possible between consolidated sleep What is the minimum number of hours consolidated sleep? What determines the timing of such sleep? What contingency exists to manage situations where there is no relief of a role holder either at the end of a shift or at the end of a shift schedule.
A1.25	How many accommodation musters would be expected between the hours 0600 to 1800 hrs and 1800 to 0600 hrs during a production period on the platform?
A1.26	How many accommodation musters would be expected between the hours 0600 to 1800 hrs and 1800 to 0600 hrs during a high activity period on the platform (such as an annual shutdown for maintenance)?
A1.27	Define the sleeping environment in terms of temperature, pressure, relative humidity, noise level (continuous and intermittent), distractions, and air movement.
A1.28	Define how an individual is selected for the role in terms of personality attributes. Is account taken of whether the individual who performs the role is to work in isolation or as part of a team?
A1.29	How are the fitness requirements for the role determined?

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

A1. ROLE CHARACTERISTICS

A1.29 Cont.	What are the fitness requirements for the role, e.g. muscle build, hearing ability, absence of colour blindness? What screening exists to determine fitness to work (psychological and physical)? Is the screening performed once as part of the recruitment process or periodically whilst the role holder is in the position? Does such screening test for drugs and alcohol abuse? Is there control of common non prescribed and prescribed drugs? How are transient illnesses such as colds and influenza handled?
A1.30	When and what food (including caffeine and alcohol) is available to the role holder?
A1.31	Is the age of the role holder taken into account with respect to psychological and physical abilities?
A1.32	What is the minimum and maximum time any individual is assigned to the role?
A1.33	What cover is available should the role holder not be available to perform the role for a given time period? How is a person to cover selected and trained? What assessment and reassessment is made to ensure the cover is competent in knowledge, skills, fitness etc.?
A1.34	Is account taken of the time of day a role holder will or could be required to perform a particular task?
A1.35	What system of recognition exists to reward good performance?
A1.36	What contingencies exist to assist a role holder who has domestic problems?
A1.37	Are an individual's language and communication skills assessed with respect to the requirements to perform the role?

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

A1. ROLE CHARACTERISTICS

A1.38	Does a sub culture exist associated with the role? Are there any superstitions associated with the role?
A1.39	Define the type and extent of distractions and interruptions, e.g. irrelevant speech, ad hoc phone calls, visitors to platform, that might be expected within the role from other people?
A1.40	Is the potential impairment from social psychological factors recognised and addressed within the working environment? Such factors include isolation from home and relatives; the relationships between the role holder and his or her peers; supervisor and sub-ordinates; group membership; culture and society norms; group norms of behaviour; group pressure and conformity; coercion; and conditioning.
A1.41	How is the Company organised to support the role holder?
A1.42	Do external pressures (Company, supervisors, peer group) to meet deadlines and perform exist?
A1.43	Does the role holder undergo annual appraisal and ranking against others?
A1.44	Where the role involves working as part of a team, what is the age and experience of other persons in the team?
A1.45	What are the irritants associated with the role, e.g. excessive quantities of irrelevant paper, electronic messaging, travel delays, excessive standards and procedures, equipment failure, repetitive false alarms and incorrect data, lack of private space?

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

The role requirements are defined as the requirements to perform the role.	
B1.1	What is the role title?
B1.2	What is required from the role according to the job description?
B1.3	What is required from the role according to those who perform the role?
B1.4	What is the total number of tasks within the role according to those who perform the role? Provide a one line description for each task. Will any of the tasks result in conflicting responsibilities?
B1.5	Which of the tasks are perceived to be stimulating by the individual who performs the role?
B1.6	Which of the tasks are perceived as monotonous by the individual who performs the role?
B1.7	Identify each task which has been termed a safety critical task (from task analysis if applicable).
B1.8	Under what circumstances are the safety critical tasks performed, i.e. normal conditions, abnormal conditions or emergency conditions?
B1.9	Which of the safety critical tasks can be planned, and which will be unplanned?
B1.10	What factors decide the timing to perform a safety critical task and the task deadlines?
B1.11	Are the safety critical tasks supervised and to what degree?
B1.12	What are the requirements for situational awareness (risk perception) for each of the safety critical tasks performed within the role?
B1.13	Do any of the safety critical tasks within a role necessitate command or supervision of others?

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.14	What is the maximum duration of the safety critical tasks within the role? Do any of the safety critical tasks require periods of vigilance?
B1.15	Do any of the safety critical tasks allow an individual to take rest breaks during their execution? How long are the rest breaks and of what do they consist?
B1.16	Do any of the safety critical tasks require a toolbox talk?
B1.17	What safety critical tasks require the completion of documentation prior to their commencement (e.g. Permit to Work)?
B1.18	Does the role require knowledge of terminology, slang, etc.?
B1.19	Does the role require fluency in the working language in order to command persons in an emergency situation?
B1.20 (a)&(b)	Taking each safety critical task in turn, what information is required and what is available to perform the tasks within the role?
B1.20 (c)	How is this information presented to the individual, e.g. verbally (directly or via telephone or radio), audibly via an alarm system, visually via gauges, computer monitor or status lights, written etc.?
B1.20 (d)	Are gauges etc. selected for ease of readability by those who will be using them?
B1.20 (e)	Are any of the controls unusual in terms of operation?
B1.20 (f)	Is any of the information colour coded? If so, what do the colours (e.g. yellow (amber), red, green, blue, white, other) represent?
B1.20 (g)	Is all information presented visually within the individual's field of vision from the normal work position?
B1.20 (h)	What is the quality of the information, is it reliable? Do any of the information sources have error which has to be corrected by the individual?

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.20 (i)	Is all necessary information readily accessible?
B1.20 (j)	Is there any information which is inferred from available information?
B1.20 (k)	What controls the timing of when information is presented? Is this information then available continuously or only for a short period of time?
B1.21	What is the maximum amount of information an individual would be expected to process at any one time: under normal situations?; abnormal situations?; and emergency situations?
B1.22	Does the role involve periods of underload which can be broken by the sudden requirement to respond to a high workload?
B1.23 (a)	What safety critical tasks require use of mentally held knowledge and/or a skill or number of skills and to what extent? How is such knowledge and/or these skills acquired, e.g. acquired elsewhere, acquired 'on the job' or by specific training with an assessment process to determine whether the skill(s) have been acquired and maintained?
B1.23 (b)	Is information obtained from the investigation of incidents used in a training programme as part of knowledge and skill acquisition?
B1.23 (c)	Where skills are tested and assessed, how is the test and assessment determined to be a valid predictor of performance in the 'on the job'?
B1.23 (d)	Where skills are assessed, how are the assessors selected and assessed?
B1.23 (e)	Is the knowledge acquired during training tested in practical applications?
B1.23 (f)	Is there any monitoring of performance 'on the job' after training?
B1.24	Are individuals trained in diagnostic, problem solving and decision making skills which will help them to cope with unfamiliar situations?
B1.25	Are infrequently used but important knowledge and skills given frequent refresher training?

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.26	Do any of the safety critical tasks involve the interpretation and mental manipulation of information or for information to be held for any length of time in the individual's memory between receipt and usage?
B1.27	Does the role require periods of passive monitoring and/or observation in isolation which are greater than half an hour?
B1.28	Do the safety critical tasks require sustained attention (concentration) for long periods of time (greater than one hour)?
B1.29	For all safety critical tasks, to what extent is information transmitted verbally between individuals (including during a handover of information)?
B1.30	Are there clear procedures for the handover of information and responsibility between different shifts and/or individuals with different responsibilities, e.g. operations and maintenance?
B1.31	For each safety critical task, what procedures and checklists exist to perform each of the tasks in the role? Who wrote these documents and how is it ensured that users understand the text? Where misunderstanding or ambiguity is identified, how is this corrected?
B1.32	Is the range of applicability of the procedures and checklists documented and identified to the users?
B1.33	Are the conditions under which the procedures must be used clear and unambiguous to the users? How are such tested?
B1.34	Is there a simple and unambiguous indexing method for users to choose the required procedures in all foreseen situations? How is such tested?
B1.35	Has the use of the provided procedures been tested 'on the job'?
B1.36	Is there a system for revising procedures in the light of experience?
B1.37	Can emergency procedures be implemented whether or not the user knows what is wrong, i.e. are they symptom based rather than event based?

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.38	What problems solving might the individual be required to perform in the execution of each of the safety critical tasks?
B1.39	What decision making might the individual be required to perform in the execution of each of the safety critical tasks?
B1.40	What is the minimum time for making a decision within the safety critical tasks? How accurate do such decisions need to be?
B1.41	Do the safety critical tasks require decisions to be made alone or part of a team?
B1.42	In teams, is the allocation of responsibility and authority clear, complete, non overlapping, known to and accepted by all individuals including the role holder(s)?
B1.43	Are any changes in these responsibilities during a non routine event or emergency clear and practised?
B1.44	Does the role include repetitive safety critical tasks? If so, what is the work and its frequency, e.g. number of times per 12 hours, number of days per week, etc.?
B1.45	Do any of the tasks required to be performed under the role necessitate physical (manual) work? What is the extent and nature of it this work?
B1.46 (a)	For any manual work that is performed: What type of work is involved, i.e. static or dynamic physical effort, and over what time period (endurance)? Is any of the movement repetitive, e.g. number of times per day, number of days per week? What is the duration of any applied physical effort? Does any movement involve excessive joint angles? Does the movement require rapid bursts of activity or activity at a steady rate over a longer period of time?

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.46 (a) Contd.	Are people assigned to the task(s) based on some measurement of physical capability? How is the measurement determined to be a valid measurement of an individual's capability?
B1.46 (b)	For manual handling (lifting) tasks in particular: What is the frequency of the lifting task(s)? What is the distance over which the load is carried? What is the time for which the load is supported by an individual? What is the weight of the load? Is the lifting operation performed by one individual? What is the height at the start of the lift? What is the height at the end of the lift? Is any training performed on how to lift? What does the training consist of and what lifting technique is taught? Is the workspace to perform the lift restricted (restricting posture)? Does the load have handles and, if so, where are they located? What is the size and shape of the object to be lifted? Under what conditions is the manual handling performed, e.g. transport up and down stairs, on floors which might be slippery, exposed locations where gusting winds might be experienced?
B1.47	What tools are available to perform the tasks within the role (including handheld tools, computers, cranes etc.)? Are any of the tools used similar but not identical in operation, e.g. computer consoles, control panels?

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1 ROLE REQUIREMENTS

B1.47 Contd.	Do any of the tools generate vibration of the user' limbs etc.? Are the tools periodically checked and maintained? What training is given in the use of the tools? Are any of the tools unusual in terms of operation or usage, e.g. handles turn clockwise for OFF and decrease or turn anti-clockwise for ON or increase?
B1.48	Do any of the tasks require the use of personal protective equipment? What personal protective equipment is required? Can this equipment restrict movement, field of vision or the individual's heat maintenance?
B1.49	What support organisation is required to perform the tasks within the role?

A2. HUMAN CHARACTERISTICS

The human characteristics are defined as the properties of the human being as opposed to his or her requirements to perform the role. The characteristics are as a result of the psychological, physiological and physical properties of human beings.

The following gives an outline of why a particular (role characteristic) factor is important to consider. However it is important that the actual effect a factor, or combination of factors, has is determined at the workplace as well as in isolation under controlled conditions and using the people who perform the role as certain factors have been shown to have task, age and gender variations and to interact with other factors.

A2.1	*Define the physical environment in which the role will be performed in terms of ambient temperature. What is the variation in this temperature. What are the extremes in terms of maximum and minimum temperature.* For a given situation, an individual's response to heat will be dependent upon ambient conditions of temperature, humidity, air velocity and radiation; the amount and type of clothing being worn (including PPE), the nature of the task; the severity of the work rate and its duration; and the physiological and physical characteristics and fitness of the individual. An individual will gain or loss heat as a result of his or her metabolism and physical work, and the convection, radiation and conduction of heat with the environment. In the consideration of ambient temperature, humidity and wind speed, it is important to consider not only the normal value but also to consider the possible extremes to which an individual might be subjected. People can physiologically survive a wide range of environmental temperatures providing that they have the correct protective clothing and equipment; however it is when an individual's core (deep) temperature varies that human failure can result. An individual (by sweating when hot, adding or removing clothing, shielding or moving away from a radiant heat source etc.) behaves to maintain a core temperature of approximately 37°C. An increase in core temperature of 3 - 4°C can lead to a deterioration in mental and physical performance, confusion, unconsciousness, coma and possible death. A decrease in core temperature can lead to impaired judgement (36°C), personality change (withdrawal), confusion, stumbling and falling (34°C) and unconsciousness (31°C). In most circumstances an individual will be aware that he or she is hot or cold and their behaviour will be to limit the effect, however where this is not possible, human failure can result. An extreme example of this is divers who require to breathe cold gas. The cold gas decreases core temperature but skin temperature remains normal and the diver is unaware of the core temperature decrease. The environmental temperature can also have indirect effects such as dehydration (which can result from an increase or decrease in temperature) which can also impair performance. In terms of mental, intellectual and manual performance, the determination of the deterioration in such as a function of ambient temperature alone is not always possible because of the number of associated factors as highlighted above.

A2. HUMAN CHARACTERISTICS

A2.1 Contd.

However research indicates that, as a general rule for elevated temperatures, a deterioration in mental and intellectual performance is observed when the ambient temperature exceeds 25°C where the individual is unacclimatised to heat and 30 to 35°C where the individual is acclimatised to the heat. Other research has indicated that both ambient temperature and time of exposure can affect mental performance (including vigilance) with high temperature causing greater impairment than increasing exposure time at a given lower temperature. Research that measures core temperature suggests that it is the change in the individual's core temperature which is associated with the impairment in vigilance.

The effects of low temperature on mental and intellectual performance are less well researched and such research has not been able to provide a general rule for minimum temperatures below which impairment in performance results. Research that has been carried out, however, suggests ambient conditions which cause a lowering of the skin temperature below the normal value of 34°C impairs mental dexterity and fine motor control and that low temperature causes distraction rather than a direct effect on the nervous system. Whilst other research suggests that it is not just an issue of distraction but also of the level of arousal. At very low temperatures, the level of arousal is high which impairs performance.

In terms of manual performance, research indicates that there is a general increase in performance up to an ambient temperature of 32°C. Performance drops as this temperature increases beyond 32°C up to 38°C (the maximum temperature studied). This research was performed on acclimatised individuals and so may not be representative for non acclimatised persons.

Where there is concern that ambient conditions could impair mental, intellectual and/or manual performance, an assessment at the worksite should be made using actual core temperature measurement and performance measurement, or available heat stress or comfort indexes. The measurements should be made by a qualified professional (e.g. ergonomist, occupational hygienist).

The following is a summarised general guideline for thermal comfort conditions: ambient temperature (as measured by a dry bulb thermometer) should be in the range 19.4 - 22.8°C for sedentary work; 15.6 - 20°C for light manual work and 12.8 - 15°C for heavy manual work; relative humidity should be in the range 50 - 60% RH; radiant temperature (as measured by a black globe thermometer) should be in the range 16.7 - 20°C for light manual work with an optimum air movement of 0.15m/s (less than 0.10 m/s is perceived as 'airless').

The American Conference of Governmental Industrial Hygienists (1976) has more detailed limit values for industrial application, based on an index known Wet Bulb Globe Temperature Index. The limit values are based on the assumption that almost all acclimatised and fully clothed workers with an appropriate fluid and salt intake should be able to work under the limit values without their core temperatures rising above 38°C.

A2. HUMAN CHARACTERISTICS

A2.1 Contd.	Further reading:	Smith, A.P., and Jones, D.M., (1992) Handbook of Human Performance, Vol. 1 The Physical Environment, pp. 79-130, London, Academic Press Ltd., for details of current research on human performance in hot and cold environments. BS 7179 (1990) Ergonomics of design and use of visual display terminals (VDTs) in offices, Part 6, Code of practice for the design of VDT work environments.
	Tests:	Psychological, Physiological, Physical.
A2.2	*Define the physical environment in which the role will be performed in terms of ambient radiative heat temperature. What is the variation in this temperature. What are the extremes in terms of the maximum and minimum radiative heat temperature.* See A1.1.	
A2.3	*Define the physical environment in which the role will be performed in terms of vibration. What is the variation in this vibration. What are the extremes in terms of the maximum and minimum vibration.* The effect of vibration on mental and physical performance is little understood, particularly the cumulative effect of vibration with other stressors (e.g. noise). There is, however, reasonable evidence to suggest that working in vibrating environments for any length of time affects both visual and manual control performance and hence affects the potential for human failure. Working in vibrating environments can also cause physical discomfort and interfere with verbal communication. The actual psychological, physiological and physical effects of vibration on the human body depend on the acceleration, frequency, amplitude, exposure time and whether the vibration is continuous or intermittent with rest breaks. The direction of the vibrating forces applied to the body determines the actual sensory and psycho-physiological reactions to the motion. An assessment should be made at the worksite to determine the effects of vibration on performance where such exists. Further reading: Smith, A.P., and Jones, D.M., (1992) Handbook of Human Performance, Vol. 1 The Physical Environment, pp. 55-78, London, Academic Press Ltd., for details of current research on human performance and vibration. Tests: Psychological, Physiological, Physical.	

A2. HUMAN CHARACTERISTICS

A2.4	*Define the physical environment in which the role will be performed in terms of surrounding ambient pressure. What is the variation in this pressure over short and long periods. What are the extremes in terms of the maximum and minimum ambient pressure.* Mental and physical performance at low ambient pressure (e.g. high altitude), is impaired although there is some evidence to suggest that individuals can acclimatise to the reduced pressure. Humans are not, however, able to acclimatise to high pressure. Exposure to very high pressure environments, such as those experienced by divers can give rise to impairment in mental performance and physiological and physical problems such as the following: tremor at 15 atm; muscle spasms, dizziness, epigastric discomfort, nausea and stomach cramps at 20 atm; and EEG changes and sleep disturbances at 30 atm. The onset of such is hastened by fast compression and delayed by slow compression. At 40 atm, hallucinations can occur. All can affect performance. The effect of pressure changes which involve the individual moving from a 'high' to a 'lower' pressure environment on the potential for human failure are generally associated with divers and the release of tissue and blood gases in solution. Such is well covered elsewhere, however working in an environment of slightly elevated pressure, e.g. pressurised modules, and movement to a lower pressure environment can cause discomfort and pain as gases expand in the gut. The discomfort and pain can cause distraction and hence affect performance on a task. Further reading: Smith, A.P., and Jones, D.M., (1992) Handbook of Human Performance, Vol. 1 The Physical Environment, pp. 177-209, London, Academic Press Ltd., for details of current research on human performance in hyperbaric environments. Tests: Psychological, physiological, physical.
A2.5	*Define the physical environment in which the role will be performed in terms of noise level (continuous and intermittent), i.e. undesired sound. What is the variation is this noise level. What are the extremes in terms of the maximum and minimum noise level. What are the noise sources.* Noise is generally thought of as an unwanted sound. The human ear is differentially sensitive to different pitches in the range 20 Hz to 20000 Hz. From approximately 19 years of age onwards there is a loss of sensitivity to the top range resulting in an audible pitch range of approximately 20 to 15000 Hz.

A2. HUMAN CHARACTERISTICS

A2.5 Contd.

The physical effects of noise can be as follows: temporary deafness, caused by short exposure to a very loud noise; permanent deafness, caused by lengthy exposure to a very loud noise or short exposure to an extremely loud noise; exposure to broadband industrial noise (i.e. a number of frequencies), causes a loss of sensitivity in the range 4000 - 5000 Hz.

The effects of noise on performance can include an inability to perceive verbal instructions and audible alarms, loss of concentration and, as research has indicated, a measured deterioration in performance in certain tasks under certain conditions.

Noise bursts have also been shown to impair performance in certain tasks where such noise bursts occur over a short period of time.

There have been a number of field studies in real life environments in support of the research findings which were observed in controlled environments. One such field study found that noise level in a factory was related to accident frequency (but not to the severity of the accident). Another such study observed that not only were accidents more frequent in an environment where there was noise, but also that young, less experienced workers were more likely to have accidents. The suggestion being that noise affects high mental workload which is a characteristic of the young inexperienced workers.

The conclusions from the above research and other work in this area are that noise can impair performance, but the precise effect is complex and depends on the nature of the noise, the characteristics of individuals exposed to the noise, and the task(s) being performed; and that investigation is required for each particular set of circumstances.

Research has also indicated that noise can interact with other factors such as nightwork and heat. This suggests that where noise exists in an environment it is important to study its effect, not just in isolation, but in the presence of the other human factors.

Further reading: Smith, A.P., and Jones, D.M., (1992) Handbook of Human Performance, Vol. 1 The Physical Environment, pp. 1-28, London, Academic Press Ltd., for details of current research on human performance and noise (including irrelevant speech).

Tests: Psychological, physiological.

A2. HUMAN CHARACTERISTICS

A2.6	*Define the physical environment in which the role will be performed in terms of air pollutants that might be present (continuous or intermittent). What is the variation in air pollutants and their maximum and minimum concentration in the atmosphere.* The main research on the effect of air pollution on human performance to date is associated with the effects of carbon monoxide, oxides of sulphur and nitrogen, particulates and ozone. In general, an excess of any pollutant is generally considered to be detrimental to health and affect performance. Further reading: Smith, A.P., and Jones, D.M., (1992) Handbook of Human Performance, Vol. 1 The Physical Environment, pp. 131-138, London, Academic Press Ltd., for details of current research on human performance and air pollution.
A2.7	*Define the physical environment in which the role will be performed in terms of relative humidity. What is the variation in relative humidity. What are the extremes in terms of the maximum and minimum relative humidity. Is the relative humidity controllable, and, if so, what factors determine the set level.* See A1.1.
A2.8	*Define the physical environment in which the role is to be performed in terms of air movement (speed and rate of change in an enclosed environment). What are the maximum and minimum values.* See A1.1.
A2.9	*Is the ambient lighting natural and/or artificial. What is the ambient lighting level, does this vary throughout a 24 hour period according to a set pattern. Can the lighting level be varied manually.* The extent to which lighting affects human performance will depend upon the visual demands of the task and the environment in which the task is performed. Insufficient lighting can impair performance, cause discomfort and drowsiness. Too much lighting (greater than 1000 lux) can also impair performance and cause discomfort due to excessive reflections, glare, shadows etc. Lighting can also cause human failure where it is too low for individuals to detect hazards in the environment which otherwise could have been avoided.

A2. HUMAN CHARACTERISTICS

A2.9 Contd.	An illumination range of 500 - 700 lux is recognised as appropriate for general office purposes. The British Standard BS 7179 (1990) Ergonomics of design and use of visual display terminals (VDTs) in offices, Part 6, Code of practice for the design of VDT work environments provides guidance on the quality and quantity of light for visual display terminal work and states that the general level of illuminance should be in the range 300 to 500 lux as measured horizontally at the work surface height. Research has indicated, however, that in environments where there exists a mixture of VDU work and other activities, such as in control rooms, individuals prefer illuminances of 250 - 300 lux. ISO8995 and BS8206 gives further recommendations for lighting levels under different applications. An artificial lighting system which is not perceived to vary in intensity by an individual may contribute to the monotony of an environment and hence may affect performance (see A2.11). One which cannot be controlled manually may cause discomfort to certain individuals. Further reading: BS 7179 (1990) Ergonomics of design and use of visual display terminals (VDTs) in offices, Part 6, Code of practice for the design of VDT work environments. Pheasant, S., (1991) Ergonomics, Work and Health, London, Taylor and Francis. Tests: Psychological.
A2.10	*Will performing the role cause an adverse change to any of the above environmental factors. If so, how and to what extent.* It is important to consider whether performing the tasks within a role will cause an adverse change in any of the above environmental conditions, and to what extent. Where the individual is also required to work under such conditions then these transient conditions also need to be considered in terms of their possible effect on human performance. Tests: Psychological, physiological, physical.
A2.11	*Is the environment in which the role is performed stimulating or monotonous.* A monotonous environment where there is very little movement and change, little activity and/or dull lighting can impair human performance as an individual in such an environment can become bored and inactive. Human failure can result particularly if the individual is suddenly required to respond to a rapidly escalating incident. Temperature, aroma and noise are also factors which affect the monotony of an environment.

A2. HUMAN CHARACTERISTICS

A2.11 Contd.	There will be individual variations in what people perceive as monotonous and it is important that the perception of the role holder(s) is established. The monotony of an environment can compound the negative effects of other factors such as lack of sleep, and time of day on human performance and induce drowsiness. It is therefore important that then environment is as stimulating as possible to the role holder(s) (but at the same time not so stimulating that it is distractive). Where this is not possible, then the individual(s) should be able to take breaks from the environment or periodically perform work which is stimulating. Tests: Psychological.
A2.12	*Is the role performed under extreme changes in environmental conditions.* The effect of extreme changes in environmental conditions on human performance should be considered. For example the effect where a role necessitates individuals to move repeatedly from high and low temperatures needs to be investigated to determine its effect on human performance and the potential for human failure.
A2.13	*Define the type and extent of distractions and interruptions that might be expected from the physical environment.* Distractions and interruptions from the physical environment will affect performance by distracting attention and breaking concentration. The full extent of distractions and interruptions (e.g. those that arise from the weather, noise, alarms, smells) should be addressed and minimised where possible.
A2.14	*Define the environment in terms of potential chemical hazards.* The potential chemical hazards to human beings are from gases, vapours, aerosols, liquids and solids (dusts and powders). Where such exist or are emitted into the atmosphere, there is the potential for human failure as a result of disease and damage to: the brain (organic solvents, alcohol, heavy metals), the lungs (sensitizers, mineral dusts, fumes and gases), the skin (drying agents, irritants, carcinogens), the nose (sensitizers, carcinogens) and the liver, kidneys and bladder (absorbed chemicals). Further reading: Control of Substances Hazardous to Health (COSHH) and Control of Carcinogenic Substances Regulations.

A2. HUMAN CHARACTERISTICS

A2.14 Contd.	American Conference of Governmental Industrial Hygienists (ACGIH) (US). Tests: Psychological, physiological, physical.
A2.15	*Define the environment in terms of potential physical hazards.* The potential physical hazards to human beings are from heat, cold, noise, vibration, ionising and non ionising radiation, external forces and loads. Where such exist, there is the potential for human failure as a result of disease and damage to: the musculo-skeletal system (from external forces and loads), skin (UV and IR light, ionising radiation), nose and lungs (ionising radiation), eye (radiant heat and light) and ears (noise). Other potential physical hazards include objects which can be impacted with, stairs, oil and grease present on floors etc. which can constitute a tripping or slipping hazard, temporary placement of cables and objects in access routes etc. machinery and equipment which is unshielded, working at height or falling overboard. Tests: Psychological, physiological, physical.
A2.16	*Define the environment in terms of potential biological hazards.* The potential biological hazards to human beings are from infectious agents, and allergenic particles such as pollen. Further reading: Control of Substances Hazardous to Health (COSHH) Regulations. Tests: Psychological, physiological, physical.
A2.17	*What are the potential chemical hazards that are introduced as a result of performing the role.* Chemical hazards can be introduced as a result of performing the role. The effect of hazards that are introduced as a result of carrying out tasks within the role should also be considered and their potential impact on the human assessed. Further reading: Control of Substances Hazardous to Health (COSHH) Regulations. Tests: Psychological, physiological, physical.

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

A2. HUMAN CHARACTERISTICS

A2.18	*What are the potential physical hazards that are introduced as a result of performing the role.* Physical hazards can be introduced as a result of performing the role. The effect of hazards that are introduced as a result of carrying out tasks within the role should also be considered and their potential impact on the human assessed. Tests: Psychological, physiological, physical.
A2.19	*What are the potential biological hazards that are introduced as a result of performing the role.* Biological hazards can be introduced as a result of performing the role. The effect of hazards that are introduced as a result of carrying out tasks within the role should also be considered and their potential impact on the human assessed. Further reading: Control of Substances Hazardous to Health (COSHH) Regulations. Tests: Psychological, physiological, physical.
A2.20	*Define the workstation/site in which the role is performed in terms dimensions and layout. Who or what determined the dimensions and layout.* *If the workstation/site is designed for human activity, is there a design standard.* *Can the workstation/site be adjusted to suit different individuals of different dimensions.* Consideration should be given to how the workstation/site was designed and whether it was based on an assessment of the tasks which were to be performed at the site and how the role holder will require to move and operate equipment and have access to equipment etc. A workstation/site which is not compatible with human interaction can provide the potential for human failure. Due to the variability in human dimensions, height, reach etc., it is important that work surfaces, seating, etc. is adjustable to suit individual requirements. Where furniture height is not adjustable, it is important to establish whether the installed height was based on anthropometric data (i.e. the physical measurement off human dimensions and movement) for a given population and whether the dimensions are suitable for the population of people who will be using the facilities.

A2. HUMAN CHARACTERISTICS

A2.20 Contd.	Where facilities are fixed and are inappropriate for the dimensions of the users, apart from discomfort which can affect concentration, the potential for human failure in terms of injury such as back injury and repetitive strain injury (upper limb disorder) will exist. It is important to consider all tasks that might be performed at the workstations (intended and actual) when considering the design and layout of any facilities. Further reading: British Standards Institute, BS7179 (1990), Ergonomics of design and use of visual display terminals (VDTs) in the offices, Part 5, Specification for VDT workstations. The Health and Safety Executive (1992), Display screen equipment work, Guidance on Regulations. Tests: Physical.
A2.21	*Where is the workstation/site located, e.g. at height, over the side of the platform, within a confined, enclosed or congested space.* See A2.20. Work at such locations should also take into account possible phobias that the role holder(s) might have with respect to height, enclosed spaces etc. and the effect this might have on concentration and the potential for human failure. Tests: Psychological, physical.
A2.22	*Are other activities outwith those associated with the role carried out at the same workstation/site.* The workstation/site should be suitable for all intended tasks that are performed there.
A2.23	*What is the duty pattern associated with the role (i.e. what is the minimum, average and maximum number of hours one person might be expected to be on duty in a 24 hour period and how many days would such a duty extend).* The potential effect of an individual whose duties include call out outwith recognised working hours should be assessed, particularly where sleeping hours are disturbed.
A2.24	*Is the role performed by more than one person to give continuous attendance with respect to time. If so, define the resultant shift schedule associated with the role. The following terminology has been used in the questions given under A2.24:*

A2. HUMAN CHARACTERISTICS

A2.24 Contd.

shift	*the time of day on a given day that a role holder is scheduled to be at the workstation/site,*
off time	*hours not normally required to be at the workstation/site,*
schedule	*sequence of consecutive shifts and off time,*
permanent hours	*schedule that does not require the role holder to work more than one shift (the time of day worked is constant),*
rotating hours	*schedule that requires the role holder to work more than one shift (the time of day worked changes),*
basic sequence	*minimum number of days of shift and off days until a sequence begins to repeat.*

What is the basic sequence of the shift schedule.

What is the normal total number of hours within each shift.

What is the maximum total number of hours within each shift.

What are the times of each shift in the shift schedule.

What is the normal number of consecutive shifts in a schedule.

What is the maximum number of consecutive shifts in a schedule.

What is the minimum, average and maximum total number of hours on shift in any preceding week.

Is the shift pattern irregular.

Is there a changeover within the shift schedule, e.g. days to nights or vice versa. and how is it performed.

What are the shift handover times and duration, and how is this performed.

What is the maximum number of hours possible between consolidated sleep.

What is the minimum number of hours consolidated sleep. What determines the timing of such sleep.

What contingency exists to manage situations where there is no relief of a role holder either at the end of a shift or at the end of a shift schedule.

A2. HUMAN CHARACTERISTICS

A2.24 Contd.	Shift work can affect human performance and cause fatigue. The effect of shift work on human performance is closely tied in with research into the circadian rhythms of the human body (i.e. biological rhythms which have a 24-28 hours cycle), particularly body temperature, and how these rhythms and their peaks and troughs affect performance. There is evidence to suggest that the peaks and troughs of shift workers can shift with respect to time whilst these workers maintain the abnormal hours of work and sleep. This and other research associated with the type of tasks performed on shift, has led to the claim that, in terms of optimum human performance, mental tasks require a different shift pattern than manual tasks. A shift pattern inconsistent with the type of work performed can therefore increase the potential for human failure. Shift work can also affect the health of individuals. It would appear that there is a higher rate of cardiovascular disease and gastrointestinal disorders amongst shift workers than people who work the traditional 'office' hours. There are some people who are unable to adapt to shift work altogether and develop what is known as 'shift maladaption syndrome' characterised by two or more medical conditions from a list which includes chronic sleep disorder, gastrointestinal disorder, cardiovascular disorder and mood disorder. The questions above exist to determine the extent to which an individual is required to adjust to an 'abnormal' pattern of work and sleep and the extent to which sleep is interfered with. These factors can both increase the potential for human failure and need to be investigated and minimised where shift work exists. Further reading: Moore-Ede, M.C. and Richardson, G.S. (1985) Shift Maladaption Syndrome, Annual Review of Medicine, 36, pp. 607-617. Tests: Psychological, physiological, physical.
A2.25	*How many accommodation musters would be expected between the hours 0600 to 1800 hrs and 1800 to 0600 hrs during a production period on the platform.* The potential effect of an accommodation muster is the disturbance of an individual's sleep period and his or her return to sleep. Although individual variations are likely, it is important to investigate the effect this might have on performance, particularly where the number is excessive. Since there will be people sleeping through daylight hours as well as night time, it is important to study both time periods. Sleep deprivation will make people tired and irritable, disrupt the individual's circadian rhythms, and increase the potential for human failure. Research indicates that sleep deprivation can become a significant factor in human performance, at least for daytime work, when an individual receives less than five hours sleep per night over a period of time. Performance impairment can be reduced if napping is possible. However the benefits of a daytime nap will depend

A2.25 Contd.	greatly on when the nap is taken, its quality, its duration and the amount of sleep deprivation an individual has experienced. There is also evidence to suggest that the benefits of napping, during the daytime or night time, are only observed two hours after the nap and that performance can actually be worse immediately after the nap (especially if the nap is taken at night). Further reading: Dinges DF, Orne MT and Orne EC, 1985, Assessing performance upon abrupt awakening from naps during quasi continuous operations. Behaviour Research Methods, Instruments and Computers, 17, 37-45. Tests: Psychological, physiological, physical.
A2.26	*How many accommodation musters would be expected between the hours 0600 to 1800 hrs and 1800 to 0600 hrs during a high activity period on the platform (such as an annual shutdown for maintenance).* As A2.25.
A2.27	*Define the sleeping environment in terms of temperature, pressure, relative humidity, noise level (continuous and intermittent), distractions, and air movement.* The environment in which an individual sleeps can affect the quality of his or her sleep and, as a result, affect mental and physical performance during waking hours. A sleeping environment which is too hot, too cold, too low in humidity, or too noisy, for example, will deprive an individual of sleep even if there is five hours minimum (see A2.25) to sleep. Investigation is required to determine what constitutes the optimum sleeping environment for the people concerned. Due to individual variations, the environment should be adjustable to an extent which can accommodate these individual variations. Tests: Psychological, physiological, physical.
A2.28	*Define how an individual is selected for the role in terms of personality attributes. Is account taken of whether the individual who performs the role is to work in isolation or as part of a team.* The personality attributes of an individual are considered to be relatively stable characteristics of that individual. The personality attributes, as measured by psychometric tests, are generally grouped into those which contribute towards interpersonal style, i.e. how the individual interacts with others; thinking style and how the individual copes with stress. The personality attributes of a role holder are important to consider since an individual who is placed in a role which is not

A2.28 Contd.	consistent with his or her personality can suffer stress, or create stress in those with whom he or she interacts. This can increase the potential for human failure. For example a person who needs to work with others will not perform well if the role requires him or her to work in isolation. Whereas if the individual is required to work as part of a team then it is important that his or her interpersonal style is consistent with such work. The tendency to risk take or adhere to rules and regulations are also measured by psychometric tests of personality and these too are important to consider when selecting an individual for a role. Tests: Psychological (psychometric tests). Note: Although psychometric tests aim to measure the relatively enduring characteristics of an individual, it is important to note that these characteristics can change with time. As a result, a psychometric test of personality is generally accepted to be a reliable assessment of personality for no longer than 6 months. After 6 months, a reassessment should be performed. Taking into account the need for periodic reassessment, psychometric tests can still provide a valuable assessment of an individual's personality, provided it is a reputable, validated test, the questions which constitute the test are answered honestly, and the results from the test are interpreted correctly by people qualified to do so.
A2.29	*How are the fitness requirements for the role determined.* *What are the fitness requirements for the role, e.g. muscle build, hearing ability, absence of colour blindness.* *What screening exists to determine fitness to work (psychological and physical). Is the screening performed once as part of the recruitment process or periodically whilst the role holder is in the position. Does such screening test for drugs and alcohol abuse.* *Is there control of common non prescribed and prescribed drugs.* A number of common drugs can impair performance and so can increase the potential for human failure. For example, research has shown that certain forms of analgesic drugs can cause impairment of human psychomotor and attentional processes which will impair performance on tasks which involve these processes. The ability of a role holder to continue with certain tasks whilst taking common drugs should therefore be established and remedial action taken if performance impairment is a possibility.

A2. HUMAN CHARACTERISTICS

A2.29 Contd.	*How are transient illnesses such as colds and influenza handled.* Research in controlled environments indicates that upper respiratory virus infections and illnesses can impair performance and so can increase the potential for human failure. The actual effects depend on the task being carried out and the type of virus. Research also indicates that the impairment to performance was not limited to the time when the person was ill, but also occurred before and after the illness was noticeable. Further research is required on real life illnesses in real working environments to take into account the fact that many tasks are practised and familiar to the worker (unlike the tasks used in the research above) and the fact that naturally occurring (real life) illnesses are typically more severe that those researched to date. The interactive effect of these illnesses with other human factors needs also to be researched further. Further reading: Smith, A.P., and Jones, D.M. (1992) Handbook of Human Performance, Vol. 2, pp 279-318 (Prescribed Psychotropic Drugs: the Major and Minor Tranquillisers), pp 319-336 (Antidepressant Drugs, Cognitive Function and Human Performance), and pp 337-385 (The Effects of Anaesthetic and Analgesic Drugs). Tests: Psychological, physiological, physical.
A2.30	*When and what food (including caffeine and alcohol) is available to the role holder.* Research indicates that the consumption of food at breakfast time for day workers can have a positive effect on memory performance. However the consumption of food at lunch time can impair performance on tasks which require sustained attention from the worker. This impairment is transient but can still be a factor which increases the potential for human failure. This post lunch impairment on sustained attention tasks can be reduced by the presence of noise or the consumption of caffeine. The extent of the impairment could also depend on how anxious the individual is, research indicates that low anxiety subjects show a greater post lunch decline in performance than high anxiety subjects. The consumption of food at night by night shift workers has also been shown to affect an individual's performance although research in this area is more limited. From research that has been carried out, it is believed that the effects of food consumed at night are qualitatively different from the effects of food consumption during the 'normal' daytime hours. For example, one investigation observed that although noise alleviated a daytime post meal performance decline, this noise did not alleviate a night time post meal performance decline. Although more research is required in this area, it can be stated that caution should be exercised when extrapolating research into the effects of food consumption during the day time to the effects of food consumption at night.

A2. HUMAN CHARACTERISTICS

A2.30 Contd.	Although there is a need for much more research in general, it does appear that food consumption can affect human performance. Where there is a decline in performance, the potential for human failure is increased. The actual effects are more difficult to state as research to date indicates that the effects of food consumption on human performance can vary with the time of day and the task studied. However the size of the meal consumed and the composition of the food may also be important compounding variables which have, as yet, not been studied in detail. The effects of caffeine consumption have also been studied, and it appears that it can improve human performance in tasks requiring sustained vigilance when taken in moderate doses as found in some foods. It has also been reported that individuals claim that they are more alert and less drowsy when such doses of caffeine have been consumed. These apparent beneficial effects of caffeine are lost when it is consumed in excessive doses or by individuals who are sensitive to it, in such cases caffeine can cause anxiety and disturb sleep. Furthermore, adverse symptoms such as headache and mood changes can result when the caffeine is suddenly withdrawn from the diet. Research into alcohol consumption and human performance indicates that alcohol impairs performance for at least 14 hours after it was consumed. Memory and decision making performance are particularly impaired. Even alcohol consumed in small quantities can impair performance, the effects being similar in magnitude to those from fatigue, boredom, hunger, eating, many commonly prescribed drugs and a number of various other risk factors. Tests: Psychological, physiological
A2.31	*Is the age of the role holder taken into account with respect to psychological and physical abilities.* Although with age comes experience, certain human functions deteriorate. Mobility, vision and hearing can all deteriorate with age and impair an individual's performance. The age of a role holder, therefore, can not be ignored in an assessment of the potential for human failure.
A2.32	*What is the minimum and maximum time any individual is assigned to the role.* Research on a wide range of different tasks indicates that it can take up to 10 years for an individual to become an expert at a task or tasks. Research indicates that the task performance of an expert is qualitatively different from an inexperienced individual. For example, experts have better recall than less experienced individuals and form different mental representations of a problem (experts classify problems within their domain of expertise in terms of underlying principles and spend time reformulating problems during problem solving).

A2.32 Contd.	Experts also have a superior level of knowledge. Therefore, where all other factors are equal between two individuals, it should not be ignored that an individual who has held a role for less than 10 years may not perform as well as one who has held the role in excess of 10 years.
A2.33	*What cover is available should the role holder not be available to perform the role for a given time period.* *How is a person to cover selected and trained.* *What assessment and reassessment is made to ensure the cover is competent in knowledge, skills, fitness etc.* Any person who is required to cover for the role holder will require the same knowledge and skills as determined to be required for the role holder, competency assessment and reassessment of the cover individual is also required. In addition, the cover individual should be able to practice the use of his or her knowledge and skills periodically to help ensure that such do not deteriorate with time.
A2.34	*Is account taken of the time of day a role holder will or could be required to perform a particular task.* An individual's performance is not constant but can vary with the time of day. Such variation is believed to be due to an individual's circadian rhythms and to other 'external' factors such as the consumption of food at particular times (see A2.30). Research in controlled environments indicates that the time of day can affect human performance on both memory and perceptual motor tasks. This work is also supported by studies in the real world. Further reading: Smith, A.P. and Jones, D.M. (1992) Handbook of Human Performance, Vol. 3, Chpt. 8 (Time of Day and Performance), London, Academic Press Ltd. Folkard,S. and Monk, T.H. (1985) Circadian Rhythms in Human Memory: in Hours of Work: Temporal Factors in Work Scheduling, edited by Folkard, S. and Monk, T.H., Chichester, Wiley. Tests: Psychological, physical.

A2. HUMAN CHARACTERISTICS

A2.35	*What system of recognition exists to reward good performance.* Most individuals are motivated by some recognition or reward for good performance. Failure to recognise or reward good performance can result in demotivation, distraction and a deterioration of performance.
A2.36	*What contingencies exist to assist a role holder who has domestic problems.* Most individuals are not able to leave behind their personal life when in the working environment. Life stress is associated with the life events and changes that are considered to be an unavoidable part of life. The death of a relative, financial worries, divorce, marriage, poor relationships with a partner or other members of the family, Christmas etc. can all distract, which can impair performance and increase the potential for human failure. In addition, such life events and changes can affect the health of an individual, which can also impair performance and increase the potential for human failure. It has also been found that effects of these life events and changes tend to be cumulative to the extent that ill health can result because a number of otherwise manageable events and changes have occurred at the same time. Where a individual fulfils a safety critical role, then the effect of life stress on his or her performance, confirmed or suspected, cannot be ignored. This particular potential cause of human failure requires skillful handling, and training will be required for most supervisors such that it is identified early and managed appropriately.
A2.37	*Are an individual's language and communication skills assessed with respect to the requirements to perform the role.* The ability to communicate such that the meaning is clearly understood by those who are intended to receive it is essential in most roles particularly those which involve safety critical tasks and the command of others in safety critical situations. Failure to successfully communicate can lead to incomplete understanding of the message and in the worst case the wrong message being received. The potential for human failure in communication (in terms of misunderstanding) can be increased where the people involved are of different nationalities, different ethnic backgrounds and different dialects. In addition many working groups tend to have their own jargon which may not be fully understood by all group members (some jargon may even have different meanings to different people). Jargon must also, therefore, be used with great care when giving safety critical instructions. In periods of high stress and workload, for example in an emergency situation, there will be an almost total reliance on verbal communication. It must be precise and send a clear unambiguous message which is understood by all concerned. Not all personnel have the skill required to do this and where individuals do not possess this skill, human failure to communicate can occur.

A2. HUMAN CHARACTERISTICS

A2.37 Contd.	Communications skills, both verbal and written, therefore need to be assessed. Where no assessment is undertaken the potential for human failure will not be recognised, addressed and minimised. Tests: Psychological.
A2.38	*Does a sub culture exist associated with the role. Are there any superstitions associated with the role* In many work areas there exist sub cultures. These are usually found in areas where the members of a group have a common purpose which is substantively different to others at the work site. In the offshore environment, for example, there are many of these sub cultures. Most are easily identifiable, for example drillers, caterers and operations teams. A number of these sub cultures may have superstitions associated with them. These sub cultures and superstitions can dictate behaviour and this capability to increase the potential for human failure when such behaviour is inappropriate cannot be ignored.
A2.39	*Define the type and extent of distractions and interruptions, e.g. irrelevant speech, ad hoc phone calls, visitors to platform, that might be expected within the role from other people.* In most roles there exists the possibility of distractions and interruptions from other people. Such disruptions and interruptions can include those which arise from irrelevant speech, ad hoc phone calls requesting information, tannoy messages, and visitors. Although ways to minimise such distractions and interruptions should be investigated and put in place, there may be little control over a number of them and the ability to cope with those which cannot be avoided is extremely important for those who hold safety critical roles or who may assume such a role in an emergency situation. The management of unavoidable distractions and interruptions by persons who fulfil such roles is, therefore, of great importance and the ability to cope with them in all circumstances needs to be assessed. Inability to perform in the presence of such distractions and interruptions can lead to human failure. Tests: Psychological, physical.
A2.40	*Is the potential performance impairment from social psychological factors recognised and addressed within the working environment. Such factors include isolation from home and relatives; the relationships between the role holder and his or her peers, supervisor and sub-ordinates; group membership; prejudice; culture and society norms of behaviour; group norms of behaviour; group pressure and conformity; coercion; and social conditioning.*

A2.40 Contd.

Stress in the working environment can result from a number of social factors, and a failure to manage these adequately by an individual or supervision. Such stress can impair performance and increase the potential for human failure.

Poor relationships with peers, supervisors and sub-ordinates, conflict, abuse of power are obvious sources of stress which can contribute to human failure (particularly in terms of human error).

Annual appraisals, the actual methods of promotion and career development etc. are an additional source of stress to an individual particularly where these are perceived as unfair and biased by the individual.

Group membership can be another stress generating social factor in the working environment. Social psychological research suggests that there exists a psychological satisfaction associated with membership of groups. The groups to which an individual feels psychologically a part (which can exist in or out of the working environment) are said to form his or her 'ingroups'.

There is also some evidence to suggest that the psychological satisfaction to be gained by group membership is enhanced by the existence of an outgroup, that is, a group which an individual does not feel part and from which he or she wishes to dissociate. Such an outgroup can be real or imaginary. Members of an outgroup can experience discrimination and even hostility by members of a given ingroup. Examples of an individual's ingroups might be those associated with a particular race, nationality, language, religion. Quite arbitrarily defined ingroups can also form in the working environment particularly wherever people have the opportunity to interact and become interdependent. Research indicates that a common goal can unite ingroup members, and that competition can exacerbate discrimination and hostility towards an outgroup. The need for such self categorisations are not fully understood, however the existence of ingroups and outgroups creates a source of stress and alienation to individuals who are not part of the main groups that might exist within the working environment. This in turn can lead to distraction and so to human failure. Where an individual is a member of an ingroup, such membership might also contribute to human failure where it affects an individual's behaviour particularly as a result of fear of rejection by other members.

Other social factors which can affects an individual's behaviour and so contribute to human failure include: culture and society norms, group norms, group pressure and pressure to conform, coercion, and social conditioning.
The negative effects of many of the social factors are difficult to eradicate, however, their capability to increase the potential for human failure cannot be ignored.

A2. HUMAN CHARACTERISTICS

A2.41	*How is the Company organised to support the role holder.* Many roles will require varying degrees of support from a Company's wider organisation. In some cases this support will be considerable and can include support in the following areas: technical, engineering, materials, personnel, logistics and emergency response. The effectiveness of this support will have an effect on the performance of the role holder particularly if it does not meet his or her requirements or expectations. Where there is inadequate or inappropriate support, then the potential for human failure exists. Organisations rarely stand still and the management of change is another aspect which can affect an individual's performance. Where the change is perceived as detrimental to the interests of individual or work team of which he or she is part, then moral can be affected and the potential for human error increased. The management of change therefore requires careful consideration with its full impact being considered before it is implemented.
A2.42	*Do external pressures (Company, supervisors, peer group) to meet deadlines and perform exist.* Role performance can be affected by the dictation of the order and timing of the tasks by external forces. Deadlines will motivate to a point (underload can lead to a deterioration of job performance), however unrealistic deadlines and too many tasks requiring attention at the same time will result in overload and a deterioration of job performance together with an increase in the potential for human failure. The potential for human failure can also be increased where tasks are rushed in order to meet tight deadlines. This is a particular problem if the pressure is applied locally, e.g. by immediate supervision.
A2.43	*Does the role holder undergo annual appraisal and ranking against others.* Whilst there are benefits associated with annual appraisal and ranking exercises, they can also have a demotivating effect on individuals where the appraisal or ranking does not meet the individual's expectations. Both can also affect the role holder's behaviour through the year where the individual believes that such behaviour could have a negative effect on his or her forthcoming appraisal or ranking, e.g. not admitting mistakes. Demotivation and inappropriate behaviour can both impair performance and increase the potential for human failure. They need, therefore, to be addressed if such exercises are performed on individuals.
A2.44	*Where the role involves working as part of a team, what is the age and experience of other persons in a team.*

A2.44 Contd.	As with personalities, inappropriate mixes of age and experience amongst individuals within a team can impair performance. As the optimum age and experience range will depend greatly on the tasks being performed, assessment is required to determine this optimum and should consider all the tasks a team will be required to perform.
A2.45	*What are the irritants associated with the role, e.g. excessive quantities of irrelevant paper, electronic messaging, travel delays, excessive standards and procedures, equipment failure, repetitive false alarms and incorrect data, lack of private space.* Irritants can be a source of stress and as such increase the potential for human failure. The presence of such irritants should be addressed and, where possible, reduced or eliminated.

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B2. HUMAN REQUIREMENTS

The human requirements are defined as the requirements to perform the role.

B2.1	*What is the role title.* See B2.3.
B2.2	*What is required from the role according to the job description.* See B2.3.
B2.3	*What is required from the role according to those who perform the role.* The job description might identify the tasks and responsibilities that were envisaged to constitute the role, however this may not necessarily reflect reality in that the job description may under or over estimate the tasks and responsibilities. The tasks and responsibilities detailed in this Role Evaluation Tool should be those which reflect reality to the role holders. The role holder(s) should therefore identify the total number of actual tasks and responsibilities that constitute the role. Since role holders will become labelled by their role title which can affect their interaction with others, it should be determined whether the role title reflects the actual tasks performed within the role and the responsibilities.
B2.4	*What is the total number of tasks within the role according to those who perform the role . Provide a one line description for each task.* *Will any of the tasks result in conflicting responsibilities.* A one line description for each task should be given. Any potential conflicts in responsibility (for example, to achieve targets) should be identified. Where such exist, the possible effect on performance should be addressed.
B2.5	*Which of the tasks are perceived to be stimulating by the individual who performs the role.* The role holder(s) should identify those tasks which they consider to be stimulating and those which they consider to be boring. This will be a subjective account given by each role holder. A high proportion of boring tasks which occupy a number of hours can affect the role holders' performance in all tasks.

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B2. HUMAN REQUIREMENTS

B2.6	*Which of the tasks are perceived as monotonous by the individual who performs the role.* See B2.5
B2.7	*Identify each task which has been termed a safety critical task (from task analysis if available).* From the total number of tasks identified above, those tasks which have been classified as safety critical (i.e. tasks which if not performed successfully could result in serious injury, fatality, loss of containment, or major damage to an installation or the environment), should be highlighted since it is these tasks which are likely to have the most significant consequences where there is human failure. These, therefore, will be the subject of later questions. Any classification of what constitutes a safety critical task should be broad enough to include those which may not be immediately apparent as being safety critical. Furthermore, where there is the possibility for non safety critical tasks to distract attention and impair performance, then these should be considered safety critical as well.
B2.8	*Under what circumstances are the safety critical tasks performed, i.e. normal conditions, abnormal conditions or emergency conditions.* The task performance of an individual will be affected by the conditions under which the task is performed. Boredom and overpractice can result in human failure when a task is performed under normal conditions. Unfamiliarity and fear can result in human failure when a task is performed under infrequent abnormal or emergency conditions.
B2.9	*Which of the safety critical tasks can be planned, and which will be unplanned.* Tasks which cannot be planned can result in human failure where there is insufficient time to plan, to provide the correct tools and information etc.
B2.10	*What factors decide the timing to perform a safety critical task and the task deadlines.* The factors which decide the timing and deadlines of tasks should be considered in terms of whether or not they are negotiable or whether they are realistic. A timing or deadline which is not negotiable or realistic can increase the potential for human failure.

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B2. HUMAN REQUIREMENTS

B2.11	*Are the safety critical tasks supervised and to what degree.* Supervision provides a means of support to role holder in the execution of tasks both in terms of assistance during periods of high activity and in monitoring the appropriateness of critical decisions taken. This quality control ensures that the role holders decision making processes where flawed can be questioned and corrective action taken before they are implemented. Pro-active competent supervision of this type enhances both the role holder's performance and experience.
B2.12	*What are the requirements for situational awareness (risk perception) for each of the safety critical tasks performed within the role.* An individual's perception of risk in an event or situation will depend on the mental model that individual has formulated in response to it. This in turn will be influenced by the individual's knowledge, experiences, expectations, motivation, information available and the amount of attention an individual is able to give to the information available. The fact that a person's perception is influenced by his or her experiences and expectations means that his or her perception is limited essentially to what he or she can conceive. Therefore risk perception can be poor if the event is outside the realm of experience of an individual. This is further exacerbated by the fact that having developed a mental model of a situation, a person will tend to seek information which will support and confirm their model and ignore further sources of information or reject that which does not support their model.
B2.13	*Do any of the safety critical tasks within a role necessitate command, control or supervision of others.* Where command, control and supervision involves interaction with other team members, situations can arise where stress loading, multi-task management and information overload on supervision can result in decreased or flawed performance. It is important that supervision are aware of the dangers which can result from this, understand the initial signs of stress and data overload and know how to successfully manage these situations. For most supervision this will require training under stressful conditions. Recent experience in this field has shown that the majority of supervision require training of this nature and that following it the awareness of their capabilities is enhanced. The training itself needs to be carefully controlled so that the subject's stress levels are constantly monitored to ensure realism without exposure to stress levels the " trainee " cannot handle. The training thus prepares the "trainee" for future exposure to stress by giving him/her experience of the physiological effects of stress so that these can be self-diagnosed in the future.

B2.13 Contd.	Training which fails to expose a " trainee " to these stress related aspects of supervision will be of little value and could result in an inferior quality of supervision being exposed later to situations they will fail to handle effectively. In addition to being a stress factor, the command or supervision or others can have a distracting effect particularly where such is not consistent with an individual's personality. Where the role holder is required to command and supervise, the distractive effect of such should be taken into account when addressing the requirement for attention and vigilance in safety critical tasks performed within the role. Psychometric tests can be used with training to help establish the ease with which an individual can command or supervise. Tests: Psychological, physiological.
B2.14 (a)	*What is the maximum duration of the safety critical tasks within the role.* Tasks which necessitate prolonged mental or physical effort can impair performance and increase the potential for human error where the individual does not take or is restricted from taking a rest break. There should be adequate competent personnel available at any one time, such that a role holder can be relieved to take a rest break. The timing and duration of such breaks will depend on the task being performed and the individual performing it. Testing will be required to establish timing and duration requirements. Tests: Psychological, physiological, physical.
B2.14 (b)	*Do any of the safety critical tasks require vigilance for sustained periods of time.* A number of roles involve tasks which require an individual to detect small but significant changes in an environment or the occurrence of unusual and critical events. Although infrequent, these changes and events can occur suddenly and without warning. Having detected such changes or events, the individual is then often required to react appropriately and rapidly in order to prevent a serious escalation of the initial change or event. According to Parasuraman (see further reading below), vigilance can be defined as an individual's 'state of readiness' to respond to these infrequent critical changes and events'.

B2. HUMAN REQUIREMENTS

B2.14 (b) Contd.	Research in the controlled environment of a laboratory indicates that most people find it difficult to remain vigilant for any significant length of time (i.e. time periods greater than one hour) and a deterioration in vigilance is observed. Where a task combines the need for almost continuous attention with a mental load on short term (working) memory, this deterioration in vigilance performance is believed to be due the inability of an individual to maintain the mental effort needed over a prolonged period of time. Other human factors can affect the vigilance performance of an individual. Studies have indicated, for example, that alcohol can impair vigilance, whilst low frequency vibration can increase vigilance. An individual's circadian rhythms can also affect vigilance. There is also evidence to suggest that there exists individual variations in vigilance performance and that introverts generally perform better than extroverts on vigilance tasks. However attempts to use psychological and physiological measurement to determine and select highly vigilant individuals for vigilant tasks has not as yet been wholly successful. Further reading: Parasuraman, R. Vigilance, Arousal and the Brain, in Gale, A., and Edwards, J.A.,1983, Physiological Correlates of Human Behaviour, Vol. II: Attention and Performance, London, Academic Press. Tests: Psychological, physiological.
B2.15	*Do any of the safety critical tasks allow an individual to take rest breaks during their execution. How long are the rest breaks and of what do they consist.* See B2.14.
B2.16	*Do any of the safety critical tasks require a toolbox talk.* Where tasks require a toolbox talk, persons who will perform the task should be given the opportunity to feedback their understanding from the talk, prior to task commencement, to ensure that they have correctly interpreted the intended message.

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B2 HUMAN REQUIREMENTS

B2.17	*What safety critical tasks require the completion of documentation prior to their commencement (e.g. Permit to Work).* Documents include checklists, permits and records. Documents can help ensure that safety requirements are implemented, authorise work to proceed, and measure safety performance. Documents are one of the management controls that can be applied to safety critical tasks.
B2.18	*Does the role require knowledge of terminology, slang, etc.* Where the role requires interaction with others and a knowledge of unique slang or terminology, human failure may result in the form of misunderstanding where an individual has insufficient knowledge of such language.
B2.19	*Does the role require fluency in the working language in order to command persons in an emergency situation.* Individuals whose native tongue is not the working language at the worksite may fail to communicate adequately in a stressful situation.
B2.20 (a)	*Taking each safety critical task in turn, what information is required to perform the tasks within the role.* All information that is required to perform each of the tasks should be listed.
B2.20 (b)	*Taking each safety critical task in turn, what information is available to perform the tasks within the role.* The actual information that is available to perform the tasks within a role should be listed. This should be compared with the information required as given above under B2.20(a). Omissions should be resolved.
B2.20 (c)	*How is this information presented to the individual, e.g. verbally (directly or via telephone or radio), audibly via an alarm system, visually via gauges, computer monitor or status lights, written etc.*
B2.20 (d)	*Are gauges etc. selected for ease of readability by those who will be using them.*

B2. HUMAN REQUIREMENTS

B2.20 (e)	*Are any of the controls unusual in terms of operation.*
B2.20 (f)	*Is any of the information colour coded. If so, what do the colours (e.g. yellow (amber), red, green, blue, white, other) represent.*
B2.20 (g)	*Is all information presented visually within the individual's field of vision from the normal work position.*
B2.20 (h)	*What is the quality of the information, is it reliable. Do any of the information sources have error which has to be corrected by the individual.*
B2.20 (i)	*Is all necessary information readily accessible.*
B2.20 (j)	*Is there any information which must be inferred from available information.*
B2.20 (k)	*What controls the timing of when information is presented. Is this information then available continuously or only for a short period of time.* The information that is available to an individual to perform the tasks within a role will have a major effect on task performance. It is vital that the information available to the individual is sufficient to perform the tasks, reliable, is presented at the right time and for adequate duration. Information which has to be inferred from other available information should be avoided where possible. The form in which the information is presented is also important. For example, audible information is omni directional and so is available to the role holder irrespective of his or her line of sight; however it can distract thought and can be transient and so can be forgotten, also although auditory information will generally be quicker to process mentally than visual information it can result in a greater number of errors; visual information is available for repeated reference and is not inhibited by background noise, but it is directional and requires to be in the role holder's field of view. All instrumentation should be tested for ease of readability by those who will be required to read them.

B2. HUMAN REQUIREMENTS

B2.20 (k) Contd.	Operation of controls should be consistent with the role holder's expectations which exist as a result of his or her knowledge and experiences both in the workplace and in everyday life. Colour coding should also be consistent with the role holders' expectations. For example from everyday life, people expect red to mean stop; therefore a red indicator which means go is likely to be misread particularly during times of stress. Where there is uncertainty as to how information should be presented, its timing and duration etc, assessments should be performed to determine the optimum for the working population concerned, taking into account the maximum amount of information that an individual could be expected to process at any one time (see B2.21). Tests: Psychological.
B2.21	*What is the maximum amount of information an individual would be expected to process at any one time: under normal situations?; abnormal situations?; and emergency situations?* Too much information, too little time to process information and/or excessive processing requirements can result in mental overload and lead to human failure. The constraints on human memory (in particular short term (working) memory) are generally considered to result as a consequence of human information processing limitations. The determination of whether or not a role holder is able to manage a particular situation (e.g. emergency) or task without overload is best carried out by simulation. The results should be considered applicable only to the individual tested since some people will perform better than others. An important factor in an individual's performance is his or her experience at the tasks. A more experienced role holder will process more information automatically which reduces the load on working memory. A simulation to determine whether there exists the potential for overload should also simulate the noise, heat or cold conditions that will exist in the working environment, as these factors can affect the point at which mental overload is reached. Other factors which can affect the point of mental overload are those which can cause fatigue, illness and emotional problems. Tests: Psychological.

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B2: HUMAN REQUIREMENTS

B2.22	*Does the role involve periods of underload which can be broken by the sudden requirement to respond to a high workload.* Mental underload can result in poor performance. If people have insufficient work to do and are under stimulated they can become bored and external information necessary to perform a task can be missed. The lack of workload can also affect an individual's ability to react quickly and correctly in an emergency. The determination of the existence of mental underload is, as with mental overload, best carried out by simulation.
B2.23 (a)	*What safety critical tasks require use of mentally held knowledge and/or a skill or number of skills and to what extent. How is such knowledge and/or these skills acquired, e.g. acquired elsewhere, acquired 'on the job' or by specific training with an assessment process to determine whether the knowledge has been acquired and not forgotten and the skill(s) have been acquired and maintained.* Consideration should be given to what knowledge and skills are required to perform the safety critical tasks, and how such knowledge and skills are acquired and maintained by an individual. Assessments should be performed to ensure that an individual has the required knowledge and/or skills irrespective of where such are supposed to have been obtained. Periodic re-assessments should also be performed to ensure that the knowledge and/or skills are maintained. This is particularly important where they are required infrequently.
B2.23 (b)	*Is information obtained from the investigation of incidents used in a training programme as part of knowledge and skill acquisition.* The investigation of real incidents provides a valuable source of information which can be used to help determine what knowledge and/or skills are required by the role holder(s). Utilisation of this information as part of a training programme assists in the acquisition of such knowledge and skills.
B2.23 (c)	*Where skills are tested and assessed, how is the test and assessment determined to be a valid predictor of performance in the 'on the job'.* Where a skill is tested and assessed as a measure of performance 'on the job', there requires to be a validation of the test and assessment which demonstrates the correlation between the test and assessment and real performance. This is especially important where the test and assessment are carried out under simulated conditions.

B2. HUMAN REQUIREMENTS

B2.23 (d)	*Where skills are assessed, how are the assessors selected and assessed.* The assessors who assess others must have demonstrated their competency in those skills being assessed.
B2.23 (e)	*Is the knowledge acquired during training tested in practical applications.* A training programme which imparts knowledge in a 'classroom' situation may not be utilised by the 'student' in the real world. He or she may fail to see its relevance in a number of practical applications particularly where the use is not obvious. Therefore a training programme should aim to relate, apply and test the use of any imparted knowledge to a number of practical applications.
B2.23 (f)	*Is there any monitoring of performance 'on the job' after training.* The knowledge and skills that a role holder actually has from previous training and experience and that which he or she is assumed to have for correct performance of a task may not be the same. It is therefore important to determine what knowledge and/or skills a role holder requires to perform a safety critical task and to test whether the role holder actually holds this information. Knowledge and/or skills that are required to perform the safety critical tasks within a role will necessitate not only suitable training but also an assessment and periodic reassessment process to determine whether the knowledge has been acquired and not forgotten, and that the skills have been acquired and maintained (see B2.23(a). To supplement the assessment and reassessment process, the monitoring of an individual on the job should also be performed particularly after any initial training. This not only provides a measure of the value of the training to an individual whilst in the working environment, but also helps early identification of any problem areas.
B2.24	*Are individuals trained in diagnostic, problem solving and decision making skills which will help them to cope with unfamiliar situations.* Individuals should be trained to develop diagnostic, problem solving and decision making skills. This training should be relevant to the safety critical tasks which they are required to perform.

B2. HUMAN REQUIREMENTS

B2.25	*Are infrequently used but important knowledge and skills given frequent refresher training.* An individual's held knowledge and skills will deteriorate with time if such are utilised infrequently, therefore it is important that the knowledge and skills required for infrequent but safety critical tasks are maintained by frequent refresher training. An assessment and reassessment process (see B2.23(a)) will assist determination of how frequent such refresher training should be and also ensure that the knowledge and skills are acquired by an individual.
B2.26	*Do any of the safety critical tasks involve the interpretation and mental manipulation of information or for information to be held for any length of time in the individual's memory between receipt and usage.* The interpretation of information has limitations as highlighted under B2.12, the mental manipulation of information introduces the further potential for human failure (in the form of error) particularly when the individual is unable to allocate sufficient mental attentional resources to such manipulation (e.g. under times of stress or distraction); new information that is required to be held in an individual's short term (working) memory for longer than 6 - 12 seconds (even that which does not exceed short term (working) memory capacity limitations can become distorted or lost (forgotten) unless sufficient attention can be given to rehearsal).
B2.27	*Does the role require periods of passive monitoring and/or observation in isolation which are greater than half an hour.* Monitoring and observation performance can deteriorate where such are carried out uninterrupted for periods longer than half and hour.
B2.28	*Do the safety critical tasks require sustained attention (concentration) for long periods of time (greater than one hour).* The ability to maintain sustained attention will deteriorate where such is carried out for periods longer than one hour.

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B2. HUMAN REQUIREMENTS

B2.29	*For all safety critical tasks, to what extent is information transmitted verbally between individuals (including during a handover of information).* The verbal transmission of information is transient and can be forgotten. Misunderstandings can result particularly where the speaker makes incorrect assumptions about what the listener does and does not know. To limit misunderstanding, the listener should feedback his understanding of a conversation to the speaker.
B2.30	*Are there clear procedures for the handover of information and responsibility between different shifts and/or individuals with different responsibilities, e.g. operations and maintenance.* The potential for human failure is increased where the procedures for handing over information and responsibilities are unclear.
B2.31	*For each safety critical task, what procedures and checklists exist to perform each of the tasks in the role? Who wrote these documents and how is it ensured that users understand the text? Where misunderstanding or ambiguity is identified, how is this corrected?* Where the author(s) and reviewer(s) of the procedures and checklists are not those who perform the role, then the role holder(s) should at least have input to their creation and review. The documents should be tested on all potential users to ensure that they fully understand their use and content. All procedures and checklists should be kept to a minimum in size for ease of use under all foreseen circumstances, but at the same time contain sufficient information to prevent wasted time in searching for cross referenced material in other documents. Text size should reflect the fact that emergency procedures and checklists will be used at times of stress and may be read under poor lighting conditions by users who have less than perfect vision. Content should also reflect the fact that users might be under stress and already have a high workload. The use of negatives in the text, e.g. "not on" instead of 'off' should be avoided as these take longer to mentally process, also the 'not' could be missed or forgotten if the text is read or heard in hurried or degraded conditions. Instructions should be ordered to reflect the order of necessary actions.
B2.32	*Is the range of applicability of the procedures and checklists documented and identified to the users.* Any assumptions or limitations in the use of a procedure or checklist should be clearly identified in the document and identified to the user.

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B2. HUMAN REQUIREMENTS

B2.33	*Are the conditions under which the procedures must be used clear and unambiguous to the users. How are such tested.* Procedures which are clear and unambiguous to the author(s) and reviewer(s) may not be so to the users. Users should have input to the creation and review of procedures and their use should be tested prior to implementation.
B2.34	*Is there a simple and unambiguous indexing method for users to choose the required procedures in all foreseen situations. How is such tested.* Any indexing method should be tested to ensure all possible users consider it simple and unambiguous.
B2.35	*Has the use of the provided procedures been tested 'on the job'.* All procedures need to be tested by the users 'on the job'. Where this is not possible, their use should be tested in simulated exercises.
B2.36	*Is there a system for revising procedures in the light of experience.* There should exist a system for revising procedures where any problems associated with a procedure or checklist can be highlighted and resolved.
B2.37	*Can emergency procedures be implemented whether or not the user knows what is wrong, i.e. are they symptom based rather than event based.* It is more often the case that a number of symptoms are known about a situation but not the actual situation event. Therefore, unless specific requirements dictate otherwise, emergency procedures should be based on likely symptoms rather than possible events.
B2.38	*What problems solving might the individual be required to perform in the execution of each of the safety critical tasks.* The type of problem solving required in a role should be taught and practised by the individual.

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B2 HUMAN REQUIREMENTS

B2.39	*What decision making might the individual be required to perform in the execution of each of the safety critical tasks.* The type of decision making required in a role should be taught and practised by the individual.
B2.40	*What is the minimum time for making a decision within the safety critical tasks. How accurate do such decisions need to be.* The less time available to make a decision then the less accurate a decision will tend to be. This is known as the speed accuracy trade off. In the extreme, where the time to make a decision is negligible an individual will have insufficient time to take in and process information and he or she will be reduced to making fast guesses. Therefore in safety critical decisions where accuracy is essential, the aim must be to provide an environment where the role holder has the maximum amount of time to gather and process (accurate) information and make a decision. Tests: Psychological.
B2.41	*Do the safety critical tasks require decisions to be made alone or part of a team.* Due to the pooling of knowledge and skills, team decision making is generally considered to produce better quality decisions and solutions to problems than the majority of the individuals in the team might produce alone. However, research indicates that such a team decision will, at best, rarely be better than the decision made alone by the most able member of the team, and there is evidence to suggest that, at worst, a team decision will be more extreme (involve greater risk) that a decision made by an individual alone. Team members might be more likely to overlook important information than individuals alone or conform to the consensus opinion. The status of individual members within a team, the compatibility of members and interpersonal relationships can also affect the final decision. These factors need to be taken into account when safety critical tasks involve the team decisions and ways to minimise their impact established.

B2. HUMAN REQUIREMENTS

B2.42	*In teams, is the allocation of responsibility and authority clear, complete, non overlapping, known to and accepted by all individuals including the role holder(s).* A role holder's responsibilities and authority should be clearly documented and identified to the role holder and to those who will be affected by such responsibilities and authority.
B2.43	*Are any changes in these responsibilities during a non routine event or emergency clear and practised.* Where there is a change in responsibility or authority as a result of a non routine event or emergency, such should be clearly documented and identified to those affected by such change.
B2.44	*Does the role include repetitive safety critical tasks. If so, what is the work and its frequency, e.g. number of times per 12 hours, number of days per week, etc.* Tasks that are performed repetitively may improve skill level and require less attention, however it is the lack of attention to a task which can also result in human failure (as mental error) particularly where a condition exists which makes a particular situation unique and different from previous occurrences.
B2.45	*Do any of the tasks required to be performed under the role necessitate physical (manual) work? What is the extent and nature of it this work?* Performance on a physical task will depend on whether the task requires repetitive movement using the same muscle groups, and static or dynamic contraction of muscle. It will also depend on an individual's muscle mass and cross sectional area, posture, motivation, and physical dimensions. Deterioration in performance or human failure (musculoskeletal injury) can result if the task requires a high degree of repetitive movement of the same muscle groups over a long period of time, and/or the task requires the long periods of static muscle contraction or excessive rapid dynamic contraction. Human failure can also result if the physical task requires an individual to adopt a poor or unstable posture, for example, as a result insufficient work space or the individual having unsuitable physical dimensions; the individual is under motivated (or too motivated and attempts a physical task beyond his/her abilities); or if the individual has insufficient muscle mass and cross sectional area to perform the task.

B2.45 Contd

Insufficient or incorrect attention to the physical work requirements of a role, to the working environment in which a physical task is to be performed, or to the human requirements can therefore result in human failure. Selection and training of an individual are also important.

The lifting of awkward or heavy loads in restricted work spaces is an obvious example of a physical task where there is the potential for human failure. However the lighter physical tasks more associated with non manual handling tasks (such as interaction with computers and 'office type' work) can also result in a range of human injuries known collectively as work related upper limb disorders. These injuries are located in the wrist, hand, arm, upper shoulder and neck of an individual. Research indicates that factors such as the amount of force being used over a period of time, the posture in which the forces are being applied, and the number of times that this occurs over a given time period all influence the likelihood that an individual can develop such disorders. Whilst the design of the work and the working environment will have the most important impact on reducing these injuries, as with the heavier physical tasks, selection and training of an individual are also important.

Further reading: Health and Safety Executive, 1990, Work related upper limb disorders, A guide to prevention, HMSO, London.

Tests: Physiological, physical.

B2.46 (a)

For any manual work that is performed:

What type of work is involved, i.e. static or dynamic physical effort, and over what time period (endurance).

In general, the greater the effort, then the greater the potential for human failure.

Is any of the movement repetitive, e.g. number of times per day, number of days per week.

In general, the more repetitive the movement, the greater the potential for human failure.

What is the duration of any applied physical effort.

Does any movement involve excessive joint angles.

B2.46 (a) Contd.	Movement requiring excessive joint angles can increase the potential for human failure. *What is the duration of any applied physical effort.* *Does any movement involve excessive joint angles.* Movement requiring excessive joint angles can increase the potential for human failure. *Does the movement require rapid bursts of activity or activity at a steady rate over a longer period of time.* Rapid bursts of activity can increase the potential for human failure. *Are people assigned to the task(s) based on some measurement of physical capability. How is the measurement determined to be a valid measurement of an individual's capability.* Not all individuals will be suitable to perform a particular physical task or tasks, therefore some form of selection will be required to minimise the potential for human failure. Those selected should also be given adequate training.
B2.46 (b)	*For manual handling (lifting) tasks in particular:* Insufficient or incorrect attention to the manual handling of loads can result in injury to the handler. Such injury can result in human failure which can result in an uncontrolled dropped load leading to impact damage of the manual handler or others in the vicinity of the manual handling operation. Sprains and strains to the manual handler are the most common type of injury. The back is the most common site of injury, the next common being the fingers/thumbs and the arm. Sprain and strain injury can arise from the incorrect application of force by the handler and/or applying a force for a long period of time. Poor posture and excessive repetition of movement can also be important contributory factors to sprain and strain injury. Many manual handling injuries are as a result of bad manual handling practice over a period of time rather than being truly attributable to any single handling incident. Consequently the injury or human failure can occur whilst handling a load which is not particularly great or awkward as well as whilst handling a heavy or awkward load.

B2.46 (b) Contd.

In Great Britain, and in other parts of the world there exists legislation that aims to protect the health and safety of an individual involved in manual handling operations. In Great Britain the majority of employees are protected by legislation that is general; for example Section 72(1) of the Factories Act (1961) states that 'a person shall not be employed to lift, carry or move any load so heavy as to be likely to cause injury to him'. The Offices, Shops and Railways Premises Act (1963) contains a similar statement. Whilst the Health and Safety at Work Act (1974, Sections 2 and 7) outlines the general duties of employers and employees, and contains no specific reference to manual handling as a separate activity. The International Labour Conference (1967) adopted ILO Convention 127 and Recommendation 128 'concerning the maximum permissible weight to be carried by one worker' in regular manual transport of loads. However, many countries, including Great Britain, have not given formal approval to these recommendations, its use is therefore limited.

In 1981, the National Institute for Occupational Safety and Health (NIOSH) USA published a work practices guide for manual lifting, which suggests two limits; the action limit (AL), below which no regulations or guidelines are necessary; and the maximum permissible limit (MPL), intended as a maximum above which manual lifting should not occur. Above the MPL any load is hazardous, whilst below the AL, the risk of injury or overexertion is minimal. Between the AL and the MPL ergonomic control is required.

In Great Britain, The Health and Safety Executive Manual Handling Operations Regulations are now in force, effective from 1st January 1993. These Regulations aim to state the minimum requirements for employers to avoid hazardous manual handling operations in the workplace 'so far as is reasonably practicable; to make an assessment of any hazardous manual handling operation that cannot be avoided so far as is reasonably practicable, and where it is not reasonably practical, then to perform other improvements to the task, the load and the working environment to reduce the risk. In line with much of the existing legislation in Great Britain, the Health and Safety Executive Regulations do not state specific weight limits requirements for manual handling operations, but it is an authoritative document which gives the minimum health and safety requirement for the manual handling of loads where there is a risk particularly from back injury to workers in any workplace. The Regulations implement the European Directive 90/269/EEC on the manual handling of loads, supplement the general responsibilities placed upon employers and employees by the Health and Safety at Work Act 1974 and the broader requirements of the Management of Health and Safety at Work Regulations 1992, and replace a number of earlier, outdated legislation.

B2.46 (b) Contd.	In Great Britain, reference should therefore be made to the Health and Safety Executive Manual Handling Operations (1992) for the minimum ergonomic requirements for manual handling operations and in association with the answers given to the questions set under B2.46b. Since these Regulations state no specific requirements on weight limits, the NIOSH guidelines which includes weight limits can also be consulted. However, since these NIOSH guidelines do not form part of the United Kingdom legislation or guidance, they can only be consulted for general information when used in Great Britain in association with the answers given under B2.46b in the absence of any specific weight limits set by the any United Kingdom authoritative body for general use. Likewise, the International Labour Conference (1967) adopted ILO Convention 127 and Recommendation 128 are available for general information in association with the answers given under B2.46b. A further publication by the Health and Safety Executive entitled 'Manual Handling - Solutions You Can Handle (1994) provides information to help employers avoid manual handling or to reduce the risk of injury where their assessment shows there is a risk associated with a manual handling operation that cannot be avoided. *What is the frequency of the lifting task(s)* *What is the distance over which the load is carried.* *What is the time for which the load is supported by an individual.* The frequency of the lift, the distance over which the load is carried and the time for which the load is supported by an individual, if excessive, can increase the potential for human failure as a result of fatigue. *What is the weight of the load.* As weight increases the risk of human failure increases. Individuals should be aware of their own limitations and the weight of the load prior to any manual handling operation. *Is the lifting operation performed by one individual.* *What is the height at the start of the lift.* The height at the start of the lift will affect the initial posture.

B2.46 (b) Contd.

What is the height at the end of the lift.

The height at the end of the lift will affect the individual's final posture.

Is any training performed on how to lift. What does the training consist of and what lifting technique is taught.

The disadvantages and advantages of different taught lifting techniques and the basic requirements for any training programme on manual handling is given in the Health and Safety Executive (1985) Manual Handling and Lifting: An Information and Literature Review with special reference to the back,

Is the workspace to perform the lift restricted (restricting posture).

A restrictive workspace to lift a load will create the potential for human failure when such restriction causes the individual to adopt an unbalanced posture which will impart excessive forces on the individual's musculoskeletal system (increasing the potential for strain or sprain injury) and cause the individual to fall, lose control of and/or drop the load or impact with solid surfaces where the individual's field of view is restricted etc.

Does the load have handles and, if so, where are they located.

Handles will assist in the manual handling operation providing they are located in a position which assists the lifting posture. The handles will also allow the manual handler to adopt a power grip where the fingers are wrapped around the handles instead of more hazardous holds such as the lumbrical (pinch) grip which is approximately six times weaker.

What is the size and shape of the objects to be lifted.

Both affect the individual's ability to grasp and hold a load and their overall centre of gravity (balance).

What type of tools are used to assist manual handling operations.

Mechanical aids to assist manual handling may only transfer the risk of injury to other parts of the human body and not remove the potential for human failure.

B2. HUMAN REQUIREMENTS

B2.46 (b) Contd.	*Under what conditions is the manual handling performed, e.g. transport up and down stairs, on floors which might be slippery, exposed locations where gusting winds might be experienced, temperature and humidity.* Manual handling in hazardous conditions will increase the risk of human failure. Manual handling under conditions of high temperature and humidity and low air movement will increase the potential for human failure due to increased sweat production as loads will be difficult to hold. Further Reading: The Health and Safety Executive (1985) Manual Handling and Lifting: An Information and Literature Review with special reference to the back, JDG Troup and FC Edwards.
B2.47	*What tools are available to perform the tasks within the role (including handheld tools, computers, control devices, cranes etc.).* For each tool, their adequacy to assist the user in the task should be assessed. Where the tools include control devices, factors such as frequency of use, sequence of use, importance of control, simultaneous use, device similarity (see below), symbolism used, spatial logic with displays, and prevention of inadvertent operation need to be addressed when assessing the adequacy in terms of control device type and control panel layout. *Are any of the tools used similar but not identical in operation, e.g. computer consoles, control panels.* Tools which are similar but not identical in operation can increase the potential for human failure (as error) particularly where the user's actions have become automatic to one particular design. *Do any of the tools generate vibration of the user' limbs etc.* Hand-arm vibration (as opposed to whole body vibration which is highlighted under A1.3) is now considered to be an important factor in human failure as a result of injury and is associated in particular with the use of tools which generate vibration in the hands and arm of the user. Important factors to consider are the acceleration of body parts caused by the vibration, the frequency and amplitude, the exposure time, and whether the exposure time is continuous or intermittent with rest breaks. The main injury associated with hand held vibrating tools is known as vibration white finger triggered when touching cold objects or exposure to the cold.

B2.47 Contd.	Vibration white finger can impair sensory performance and lead to a loss of manual dexterity and finger co-ordination in the early stages of the injury. Further exposure to vibration can cause progression to more severe injury. Further reading: The injury is still to be fully understood, however the Health and Safety Executive have produced a document entitled Hand Arm Vibration (1994). *Are the tools periodically checked and maintained.* *What training is given in the use of the tools.* *Are any of the tools unusual in terms of operation or usage, e.g. handles turn clockwise for OFF and decrease or turn anti-clockwise for ON or increase.*
B2.48	*Do any of the tasks require the use of personal protective equipment. What personal protective equipment is required. Can this equipment restrict movement, field of vision or the individual's heat maintenance.* Personal protective equipment which is issued to an individual may restrict movement, field or vision or affect the individual's heat balance. These factors must be considered when determining the human requirements to perform a task.
B2.49	*What support organisation is required to perform the tasks within the role.* The support organisation required to perform a task, particularly safety critical tasks, should be identified and put in place to ensure that they are available when required (e.g. 24 hours a day, every day). See also A2.41.

APPENDIX - WORKED EXAMPLE

A1. ROLE CHARACTERISTICS

Work Role: Offshore Deck Crew & Heli-Deck Assistant (HDA)

(Answers to questions are in italics).

A1.1	Define the physical environment in which the role will be performed in terms of ambient temperature. What is the variation in this temperature. What are the extremes in terms of maximum and minimum temperature? *Working temperature range minus 5 to plus 20 degrees centigrade (excluding wind chill).*
A1.2	Define the physical environment in which the role will be performed in terms of ambient radiative heat temperature. What is the variation in this temperature? What are the extremes in terms of the maximum and minimum radiative heat temperature? *Heat radiation possible from platform flare when working on heli-deck. Maximum and minimum radiative heat transfer requires measurement. Maximum duration on heli-deck approximately one hour under normal circumstances.*
A1.3	Define the physical environment in which the role will be performed in terms of vibration. What is the variation in this vibration? What are the extremes in terms of the maximum and minimum vibration? *No severe vibration.*
A1.4	Define the physical environment in which the role will be performed in terms of surrounding ambient pressure. What is the variation in this pressure over short and long periods? What are the extremes in terms of the maximum and minimum ambient pressure? *Not applicable.*
A1.5	Define the physical environment in which the role will be performed in terms of noise level (continuous and intermittent), i.e. undesired sound. What is the variation is this noise level? What are the extremes in terms of the maximum and minimum noise level? What are the noise sources? *Noise level high during helicopters movements (ear defenders worn). Maximum noise levels require measurement.*

APPENDIX - WORKED EXAMPLE

A1. ROLE CHARACTERISTICS

A1.6	Define the physical environment in which the role will be performed in terms of air pollutants that might be present (continuous or intermittent). What is the variation in air pollutants and their maximum and minimum concentration in the atmosphere? *Air pollutants mainly from helicopter exhaust gases on heli-deck and turbine exhaust gases.*
A1.7	Define the physical environment in which the role will be performed in terms of relative humidity. What is the variation in relative humidity? What are the extremes in terms of the maximum and minimum relative humidity? Is the relative humidity controllable, and, if so, what factors determine the set level? *Weather determines relative humidity.*
A1.8	Define the physical environment in which the role is to be performed in terms of air movement (speed and rate of change in an enclosed environment). What are the maximum and minimum values? *Air movement determined by weather (wind speed) and draught from helicopters. Both can be hazardous especially wind speed when gusting.*
A1.9 (a)	Is the ambient lighting natural and/or artificial? What is the ambient lighting level, does this vary throughout a 24 hour period according to a set pattern? Can the lighting level be varied manually? *Ambient lighting is natural during the day and artificial (floodlights) during the hours of darkness. Restricted work in poor lighting conditions, e.g. fog or snow.*
A1.9 (b)	What is the main colour scheme of the environment? *Sea and sky.*
A1.10	Will performing the role cause an adverse change to any of the above environmental factors? If so, how and to what extent? *Main factor to change is air movement as a result of helicopter movements.*

APPENDIX: WORKED EXAMPLE

A1. ROLE CHARACTERISTICS

A1.11	Is the environment in which the role is performed stimulating or monotonous? *Monotonous during normal operations.*
A1.12	Is the role performed under extreme changes in environmental conditions? *Yes due to changes in weather (wind, rain, storms etc.) and helicopter movements.*
A1.13	Define the type and extent of distractions and interruptions that might be expected from the environment. *Main distractions are as a result of noise (e.g. process blowdown, drilling activities, PA announcements, container impact, crane engines). Other distractions include working in wet clothing, restricted hearing as a result of wearing ear defenders), platform general platform alarm.*
A1.14	Define the environment in terms of potential chemical hazards. *Handle and work with numerous chemicals including chemicals transported by air and sea, detergents, and aviation fuel.*
A1.15	Define the environment in terms of potential physical hazards. *Stairs, crane hooks, tripping hazards on heli-deck, helicopter rotor blades.*
A1.16	Define the environment in terms of potential biological hazards. *Not applicable.*
A1.17	What are the potential chemical hazards that are introduced as a result of performing the role? *Handling and working with production and drilling chemicals transported by air and sea, detergents used for cleaning decks, re-fuelling helicopters.*
A1.18	What are the potential physical hazards that are introduced as a result of performing the role? *Movement of cargo loads, crane lifting from supply vessels, helicopter rotor blades.*

APPENDIX - WORKED EXAMPLE

A1. ROLE CHARACTERISTICS

A1.19	What are the potential biological hazards that are introduced as a result of performing the role? *Not applicable.*
A1.20	Define the workstation/site in which the role is performed in terms dimensions and layout? Who or what determined the dimensions and layout? *Dimensions of worksite are variable (heli-deck, loading areas etc.), layout also variable (container shape and put-down location, aircraft type etc.).* If the workstation/site is designed for human activity, is there a design standard? *The worksite is not designed for human activity.* Can the workstation/site be adjusted to suit different individuals of different dimensions? *No.*
A1.21	Where is the workstation/site located, e.g. at height, over the side of the platform, within a confined, enclosed or congested space? *Worksite can be at height and/or in a confined or congested space.*
A1.22	Are other activities outwith those associated with the role carried out at the same workstation/site? *Yes, drilling and craning activities.*
A1.23	What is the duty pattern associated with the role (i.e. what is the minimum, average and maximum number of hours one person might be expected to be on duty in a 24 hour period and how many days would such a duty extend)? *Minimum number of hours is 12, maximum is 16 hours over a 14 day duty period. On call period is 24 hours a day over a 14 day period in response to emergencies.*

APPENDIX - WORKED EXAMPLE

A1. ROLE CHARACTERISTICS

A1.24

Is the role performed by more than one person to give continuous attendance with respect to time? If so, define the resultant shift schedule associated with the role? The following terminology has been used in the questions given under A1.24:

shift	the time of day on a given day that a role holder is scheduled to be at the workstation/site,
off time	hours not normally required to be at the workstation/site,
schedule	sequence of consecutive shifts and off time,
permanent hours	schedule that does not require the role holder to work more than one shift (the time of day worked is constant),
rotating hours	schedule that requires the role holder to work more than one shift (the time of day worked changes),
basic sequence	minimum number of days of shift and off days until a sequence begins to repeat.

The work role is performed by three persons plus a supervisor..

What is the basic sequence of the shift schedule?

14 days of shift days and 14 off days.

What is the normal total number of hours within each shift?

12 hours.

What is the maximum total number of hours within each shift?

16 hours.

What are the times of each shift in the shift schedule?

0700 hrs to 1900 hours.

A1. ROLE CHARACTERISTICS

A1.24 Contd.	What is the normal number of consecutive shifts in a schedule? *14.* What is the maximum number of consecutive shifts in a schedule? *14 (unless adverse weather prevents crew change).* What is the minimum, average and maximum total number of hours on shift in any preceding week ? *0 hours, 84 hours and 112 hours (maximum).* Is the shift pattern irregular? *The shift pattern is regular.* Is there a changeover within the shift schedule, e.g. days to nights or vice versa. and how is it performed? *There is no changeover within the shift schedule.* What are the shift handover times and duration, and how is this performed? *A verbal shift handover occurs at crew change (at end of 14 days).* What is the maximum number of hours possible between consolidated sleep? *11 hours.* What is the minimum number of hours consolidated sleep? What determines the timing of such sleep? *7 hours providing no interruptions. The timing of the sleep is determined by shift hours.* What contingency exists to manage situations where there is no relief of a role holder either at the end of a shift or at the end of a shift schedule. *No contingency.*

APPENDIX - WORKED EXAMPLE

A1. ROLE CHARACTERISTICS

A1.25	How many accommodation musters would be expected between the hours 0600 to 1800 hrs and 1800 to 0600 hrs during a production period on the platform? *Maximum of 1 to 2 between 0600-1800 hrs and 2 to 3 between 1800-0600 hrs.*
A1.26	How many accommodation musters would be expected between the hours 0600 to 1800 hrs and 1800 to 0600 hrs during a high activity period on the platform (such as an annual shutdown for maintenance)? *As in A1.25 but can be higher during process start ups.*
A1.27	Define the sleeping environment in terms of temperature, pressure, relative humidity, noise level (continuous and intermittent), distractions, and air movement. *Sleeping environment can be draughty, noisy with a high number of distractions. Actual measurements required for temperature and relative humidity.*
A1.28	Define how an individual is selected for the role in terms of personality attributes. Is account taken of whether the individual who performs the role is to work in isolation or as part of a team? *Personality attributes not considered in selection process.*
A1.29	How are the fitness requirements for the role determined? *Specific physical fitness for the role not assessed.* What are the fitness requirements for the role, e.g. muscle build, hearing ability, absence of colour blindness? *Not defined but important factors to measure are considered by the role holder to be muscle build, hearing ability, alertness, eyesight.* What screening exists to determine fitness to work (psychological and physical)? Is the screening performed once as part of the recruitment process or periodically whilst the role holder is in the position? Does such screening test for drugs and alcohol abuse? *Company medical performed prior to selection, thereafter every two years up to the age of 50 yrs and once every year after the age of 50 years. Screening for drugs and alcohol (at medical and where abuse is suspected).*

APPENDIX - WORKED EXAMPLE

A1. ROLE CHARACTERISTICS

A1.29 Cont.	Is there control of common non prescribed and prescribed drugs? *Use of prescribed drugs should be reported to the offshore medic.* How are transient illnesses such as colds and influenza handled? *Symptoms handled by offshore medic.*
A1.30	When and what food (including caffeine and alcohol) is available to the role holder? *Food is available at regular meal times, caffeine is available (in coffee and tea) throughout. No alcohol is allowed at any time whilst offshore).*
A1.31	Is the age of the role holder taken into account with respect to psychological and physical abilities? *No.*
A1.32	What is the minimum and maximum time any individual is assigned to the role? *The role holder is permanently assigned to the role.*
A1.33	What cover is available should the role holder not be available to perform the role for a given time period? *There is no cover other than from the other two individuals in the team.* How is a person to cover selected and trained? *Not applicable (no cover).* What assessment and reassessment is made to ensure the cover is competent in knowledge, skills, fitness etc.? *Not applicable (no cover).*

APPENDIX - WORKED EXAMPLE

A1 ROLE CHARACTERISTICS

A1.34	Is account taken of the time of day a role holder will or could be required to perform a particular task? *No.*
A1.35	What system of recognition exists to reward good performance? *None.*
A1.36	What contingencies exist to assist a role holder who has domestic problems? *Compassionate leave at discretion of OIM, access to a telephone.*
A1.37	Are an individual's language and communication skills assessed with respect to the requirements to perform the role? *No.*
A1.38	Does a sub culture exist associated with the role? Are there any superstitions associated with the role? *Yes. An individual may be superstitious.*
A1.39	Define the type and extent of distractions and interruptions, e.g. irrelevant speech, ad hoc phone calls, visitors to platform, that might be expected within the role from other people? *Main distractions and interruptions come from tannoy announcements.*
A1.40	Is the potential impairment from social psychological factors recognised and addressed within the working environment? Such factors include isolation from home and relatives; the relationships between the role holder and his or her peers; supervisor and sub-ordinates; group membership; culture and society norms; group norms of behaviour; group pressure and conformity; coercion; and conditioning. *Such factors are given minimum attention.*

APPENDIX - WORKED EXAMPLE

A1. ROLE CHARACTERISTICS

A1.41	How is the Company organised to support the role holder? *Onshore support exists for routine and emergency operations.*
A1.42	Do external pressures (Company, supervisors, peer group) to meet deadlines and perform exist? *Yes.*
A1.43	Does the role holder undergo annual appraisal and ranking against others? *No.*
A1.44	Where the role involves working as part of a team, what is the age and experience of other persons in the team? *Variable. Supervisor is generally the oldest most experienced member of the team.*
A1.45	What are the irritants associated with the role, e.g. excessive quantities of irrelevant paper, electronic messaging, travel delays, excessive standards and procedures, equipment failure, repetitive false alarms and incorrect data, lack of private space? *Travel delays, weather, restricted working space, handling materials in a hurry, dual role.*

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

The role requirements are defined as the requirements to perform the role.	
B1.1	What is the role title? *Offshore Deck Crew and Heli-Deck Assistant.*
B1.2	What is required from the role according to the job description? *Assist with the preparation for embarkation and disembarkation of aircraft passengers, for the unloading and loading of passenger baggage, and for the receipt and despatch of freight, supplies and equipment to/from the platform by air and sea.* *Operate appropriate procedures for embarkation and disembarkation of aircraft passengers, for the unloading and loading of passenger baggage, and for the receipt and despatch of freight, supplies and equipment to/from the platform by air and sea.* *Complete the above activities.* *Assist with the preparation for re-fuelling helicopters, re-fuelling and shutdown of re-fuelling operations.* *Heli-Deck Firefighting Response and Emergency Response.*
B1.3	What is required from the role according to those who perform the role? *As above.*
B1.4	What is the total number of tasks within the role according to those who perform the role? Provide a one line description for each task. *As given in Job Description.* Will any of the tasks result in conflicting responsibilities? *No.*

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.5	Which of the tasks are perceived to be stimulating by the individual who performs the role? *No routine tasks are perceived to be stimulating..*
B1.6	Which of the tasks are perceived as monotonous by the individual who performs the role? *All routine tasks are perceived as monotonous.*
B1.7	Identify each task which has been termed a safety critical task (from task analysis if applicable). *Fire fighting, aircraft handling and lifting operations. Back up emergency response team.*
B1.8	Under what circumstances are the safety critical tasks performed, i.e. normal conditions, abnormal conditions or emergency conditions? *Tasks can be performed under all conditions.*
B1.9	Which of the safety critical tasks can be planned, and which will be unplanned? *Most tasks are planned.*
B1.10	What factors decide the timing to perform a safety critical task and the task deadlines? *Timing and deadlines are determined by aircraft and shipping movements.*
B1.11	Are the safety critical tasks supervised and to what degree? *Tasks are supervised by the HLO and Supervisor to a high degree.*
B1.12	What are the requirements for situational awareness (risk perception) for each of the safety critical tasks performed within the role? *High.*

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.13	Do any of the safety critical tasks within a role necessitate command or supervision of others? *Command and supervision of aircraft passengers, ships' deckcrew crane operator and drilling deck crew required.*
B1.14	What is the maximum duration of the safety critical tasks within the role? *Up to 2 hours.* Do any of the safety critical tasks require periods of vigilance? *Yes, particularly those associated with aircraft and shipping.*
B1.15	Do any of the safety critical tasks allow an individual to take rest breaks during their execution? How long are the rest breaks and of what do they consist? *No.*
B1.16	Do any of the safety critical tasks require a toolbox talk? *Toolbox talks not given.*
B1.17	What safety critical tasks require the completion of documentation prior to their commencement (e.g. Permit to Work)? *Most tasks associated with aircraft and shipping movements involve completion of documentation.*
B1.18	Does the role require knowledge of terminology, slang, etc.? *Yes.*
B1.19	Does the role require fluency in the working language in order to command persons in an emergency situation? *Yes.*

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.20 (a)&(b)	Taking each safety critical task in turn, what information is required and what is available to perform the tasks within the role? *No identified deficiencies providing documentation complete.*
B1.20 (c)	How is this information presented to the individual, e.g. verbally (directly or via telephone or radio), audibly via an alarm system, visually via gauges, computer monitor or status lights, written etc.? *Most information is presented verbally via radio.*
B1.20 (d)	Are gauges etc. selected for ease of readability by those who will be using them? *No.*
B1.20 (e)	Are any of the controls unusual in terms of operation? *No. However tools used can be unfamiliar with limited/no instruction.*
B1.20 (f)	Is any of the information colour coded? If so, what do the colours (e.g. yellow (amber), red, green, blue, white, other) represent? *Yes, lifting equipment is colour coded following testing.*
B1.20 (g)	Is all information presented visually within the individual's field of vision from the normal work position? *No.*
B1.20 (h)	What is the quality of the information, is it reliable? Do any of the information sources have error which has to be corrected by the individual? *Verbal information can be in error.*
B1.20 (i)	Is all necessary information readily accessible? *No, for example information on manifests may be incomplete.*

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.20 (j)	Is there any information which is inferred from available information? *No.*
B1.20 (k)	What controls the timing of when information is presented? Is this information then available continuously or only for a short period of time? *External factors control the timing of when information is presented. Information (verbal) is available only for a short period of time.*
B1.21	What is the maximum amount of information an individual would be expected to process at any one time: under normal situations?; abnormal situations?; and emergency situations? *Amount of information can be high under all conditions.*
B1.22	Does the role involve periods of underload which can be broken by the sudden requirement to respond to a high workload? *Yes.*
B1.23 (a)	What safety critical tasks require use of mentally held knowledge and/or a skill or number of skills and to what extent? How is such knowledge and/or these skills acquired, e.g. acquired elsewhere, acquired 'on the job' or by specific training with an assessment process to determine whether the skill(s) have been acquired and maintained? *All tasks require the use of mentally held knowledge and skills. The knowledge and skills are acquired on the job with some offsite training.*
B1.23 (b)	Is information obtained from the investigation of incidents used in a training programme as part of knowledge and skill acquisition? *No.*

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.23 (c)	Where skills are tested and assessed, how is the test and assessment determined to be a valid predictor of performance in the 'on the job'? *Main required skills are tested and assessed at HDA Course. No validation of course known.*
B1.23 (d)	Where skills are assessed, how are the assessors selected and assessed? *Main skills assessed are movement around heli-deck, handling passengers and loads, re-fuelling of aircraft, heli-deck firefighting. Not known how assessors are selected and assessed.*
B1.23 (e)	Is the knowledge acquired during training tested in practical applications? *Only for emergency response.*
B1.23 (f)	Is there any monitoring of performance 'on the job' after training? *Yes.*
B1.24	Are individuals trained in diagnostic, problem solving and decision making skills which will help them to cope with unfamiliar situations? *No.*
B1.25	Are infrequently used but important knowledge and skills given frequent refresher training? *No, not for deck crew. Emergency response and HDA refresher training is given once every two years.*
B1.26	Do any of the safety critical tasks involve the interpretation and mental manipulation of information or for information to be held for any length of time in the individual's memory between receipt and usage? *Yes.*

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.27	Does the role require periods of passive monitoring and/or observation in isolation which are greater than half an hour? *No.*
B1.28	Do the safety critical tasks require sustained attention (concentration) for long periods of time (greater than one hour)? *Yes.*
B1.29	For all safety critical tasks, to what extent is information transmitted verbally between individuals (including during a handover of information)? *Most information is transmitted verbally.*
B1.30	Are there clear procedures for the handover of information and responsibility between different shifts and/or individuals with different responsibilities, e.g. operations and maintenance? *No.*

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.31	For each safety critical task, what procedures and checklists exist to perform each of the tasks in the role? Who wrote these documents and how is it ensured that users understand the text? Where misunderstanding or ambiguity is identified, how is this corrected? *A number of procedures exist (External and Company, e.g. Personnel Procedures, Procedures to Secure Safety of Installation, Emergency Procedures Manual, Lifting and Slinging Procedures, Firefighting Regulations and Procedures, Heli-Deck Checks, Helicopter Communications, Helicopter Landing and Unloading, Helicopter Loading, Dangerous Goods Handled by Sea and Air, Helicopter Re-fuelling, Deck Cleaning Procedures, Heli-Deck Equipment Preparation).* *Procedures generally written by others with no checking for understanding by the user.*
B1.32	Is the range of applicability of the procedures and checklists documented and identified to the users? *Not always, generally left to supervisor.*
B1.33	Are the conditions under which the procedures must be used clear and unambiguous to the users? How are such tested? *Not tested.*
B1.34	Is there a simple and unambiguous indexing method for users to choose the required procedures in all foreseen situations? How is such tested? *Procedures can have indexes but not tested for simplicity and ambiguity.*
B1.35	Has the use of the provided procedures been tested 'on the job'? *No.*

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.36	Is there a system for revising procedures in the light of experience? *Incident Reporting System.*
B1.37	Can emergency procedures be implemented whether or not the user knows what is wrong, i.e. are they symptom based rather than event based? *Most procedures are event based.*
B1.38	What problems solving might the individual be required to perform in the execution of each of the safety critical tasks? *Most problem solving would be performed by supervisor.*
B1.39	What decision making might the individual be required to perform in the execution of each of the safety critical tasks? *Decision making is in terms of own safety and safety of others.*
B1.40	What is the minimum time for making a decision within the safety critical tasks? *Seconds.* How accurate do such decisions need to be? *Decisions need to be accurate.*
B1.41	Do the safety critical tasks require decisions to be made alone or part of a team? *Variable.*
B1.42	In teams, is the allocation of responsibility and authority clear, complete, non overlapping, known to and accepted by all individuals including the role holder(s)? *Yes.*

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.43	Are any changes in these responsibilities during a non routine event or emergency clear and practised? *Not always.*
B1.44	Does the role include repetitive safety critical tasks? If so, what is the work and its frequency, e.g. number of times per 12 hours, number of days per week, etc.? *Yes, three to four times per day (handling aircraft passengers and baggage etc.)*
B1.45	Do any of the tasks required to be performed under the role necessitate physical (manual) work? What is the extent and nature of it this work? *Yes, deck cleaning, lifting operations and emergency response.*
B1.46 (a)	For any manual work that is performed: What type of work is involved, i.e. static or dynamic physical effort, and over what time period (endurance)? *Most manual work is dynamic for periods up to 30 minutes where a task can be repeated every 30 seconds up to 36 times..* Is any of the movement repetitive, e.g. number of times per day, number of days per week? *Yes, unloading and loading aircraft baggage, approximately 36 times per aircraft.* What is the duration of any applied physical effort? *Up to 30 minutes.*
	Does any movement involve excessive joint angles? *Yes.*

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.46 (a) Contd.	Does the movement require rapid bursts of activity or activity at a steady rate over a longer period of time? *Tasks can involve both types of activity.*
	Are people assigned to the task(s) based on some measurement of physical capability? How is the measurement determined to be a valid measurement of an individual's capability? *No.*
B1.46 (b)	For manual handling (lifting) tasks in particular: What is the frequency of the lifting task(s)? *Variable.* What is the distance over which the load is carried? *Up to 30 feet.* What is the time for which the load is supported by an individual? *Approximately 30 seconds.* What is the weight of the load? *25 lb to 56 lb.* Is the lifting operation performed by one individual? *Yes.* What is the height at the start of the lift? *0 to 3 feet.*

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1 ROLE REQUIREMENTS

B1.46 (b) Cont.	What is the height at the end of the lift? *0 to 3 feet.* Is any training performed on how to lift? What does the training consist of and what lifting technique is taught? *No.* Is the workspace to perform the lift restricted (restricting posture)? *Yes.*
B1.46 (b) cont.	Does the load have handles and, if so, where are they located? *Not all loads have handles.* What is the size and shape of the object to be lifted? *Variable.* Under what conditions is the manual handling performed, e.g. transport up and down stairs, on floors which might be slippery, exposed locations where gusting winds might be experienced? *Manual handling is performed under all conditions stated above.*
B1.47	What tools are available to perform the tasks within the role (including handheld tools, computers, cranes etc.)? *Mechanical lifting equipment is available for lifting heavy loads. High pressure cleaning equipment.* Are any of the tools used similar but not identical in operation, e.g. computer consoles, control panels? *No.*

ROLE CHARACTERISTICS AND REQUIREMENTS VERSUS HUMAN CHARACTERISTICS AND REQUIREMENTS

B1. ROLE REQUIREMENTS

B1.47 Contd.	Do any of the tools generate vibration of the user' limbs etc.? *No.* Are the tools periodically checked and maintained? *Yes.* What training is given in the use of the tools? *Minimum training given.* Are any of the tools unusual in terms of operation or usage, e.g. handles turn clockwise for OFF and decrease or turn anti-clockwise for ON or increase? *No.*
B1.48	Do any of the tasks require the use of personal protective equipment? What personal protective equipment is required? Can this equipment restrict movement, field of vision or the individual's heat maintenance? *Most tasks require the use of personal protective equipment (safety boots, coveralls, visors, ear defenders. safety glasses, gloves, slick suits, waterproof clothing, fireman suits).* *Equipment can restrict movement, restrict field of vision (glasses) and handling ability (gloves).*
B1.49	What support organisation is required to perform the tasks within the role? *Onshore support for management of passengers and freight.*

APPENDIX - WORKED EXAMPLE

SUMMARY OF ASSESSMENT OF RESPONSES (COMPARISON WITH SECTIONS A2 AND B2):

The above represents an initial investigation into the role of Offshore Deck Crew and Heli-Deck Assistent to provide a worked example on how to utilise the RET. Actual use of the RET would aim to provide more detailed responses to the questions given in Sections A1 and B1.

Comparison of the responses (in italics) with Sections A2 and B2 of the RET indicates that the effects of the physical environment on performance require further investigation. Such an investigation should include determination of the effects of temperature, heat radiation, air movement, physical hazards, distractions and interruptions on performance.

Whilst the majority of other responses highlight at least some inconsistency with the information and guidance given in Sections A2 and B2 which require further investigation, other main areas of investigation are considered to be the handling of chemical freight, effect of shift work, the selection process of individuals for the work role, training and assessment requirements, communication, the testing of procedures for understanding and ease of use by the role holder, the manual handling of loads in the physical environment experienced by the role holder, and the selection of personal protective equipment to minimise movement and field of vision etc. restrictions.

The responses are consistent with an assessment of the main type of accidents that occur in the working environment for Deck Crew and Heli-Deck Assistants. These accidents include injuries from the performance of manual work in a restricted space, insecure loads in containers, incomplete labelling on freight (e.g. incomplete weight labelling), blind lifting and spillages.

JOINT INDUSTRY PROJECT ON HUMAN FACTORS IN OFFSHORE OPERATIONS

APPENDIX E

HUMAN ERROR ASSESSMENT TOOL

(HEAT)

DRAFT VERSION B

TABLE OF CONTENTS

TABLES

FORMS

INTRODUCTION

The Human Error Assessment Tool (HEAT) is designed to allow teams of trained users to examine activities from a Human Factors (HF) perspective. The purpose of the HEAT is to identify possible system-induced human errors, prioritize these errors based on relative financial or safety impact, and analyze critical errors using an HF model in order to identify appropriate corrective measures for improving system performance.

SCOPE

Although the HEAT can be applied to any system, the goal of the JIP is to design a tool that is appropriate to the culture and resource availability of the offshore oil and gas industry.

LIMITATIONS

The HEAT is a systematic approach to analyzing an activity for human error. However, the user should not expect that application of human error assessment will identify and correct all possible sources of human error in a system. The value of human error assessment lies in the insight into the causes of human error that the analysis provides. This insight results in a unique perspective on how to modify an activity or system to reduce the potential for damaging human error.

Unfortunately, human error assessment cannot be used as the **single** tool for identifying system improvements. The HEAT compliments other hazard identification tools such as hazard and operability studies (HAZOP), fault tree analysis, event tree analysis,

etc. The user will notice some similarities between the HEAT and these other hazard identification methods. When used appropriately and in conjunction with these other tools, human error assessment can help identify unique, cost-effective measures for system improvement.

GENERAL APPROACH

The approach involves examining the individual steps that people perform when conducting an activity in order to identify potential human errors. Once identified, each error is then subjectively analyzed and rated for its potential impact to system performance as well as its likelihood of occurrence. Rating the errors provides a means to prioritize the application of corrective measures for error reduction. High-priority, or critical, errors are the focus of the human factors error analysis, since eliminating these errors will result in the greatest overall system improvement.

Application of the HEAT involves three steps (Gross Task Analysis, Human Error Identification, and Error Analysis and Corrective Measures) that attempt to answer the following questions:

Gross Task Analysis

1. What is the activity of interest?
2. What are the major tasks performed in the activity?
3. What are the steps performed in each major task?

Human Error Identification

4. What are the potential errors for each step?

5. How likely is each error?

6. What is the consequence of each error?

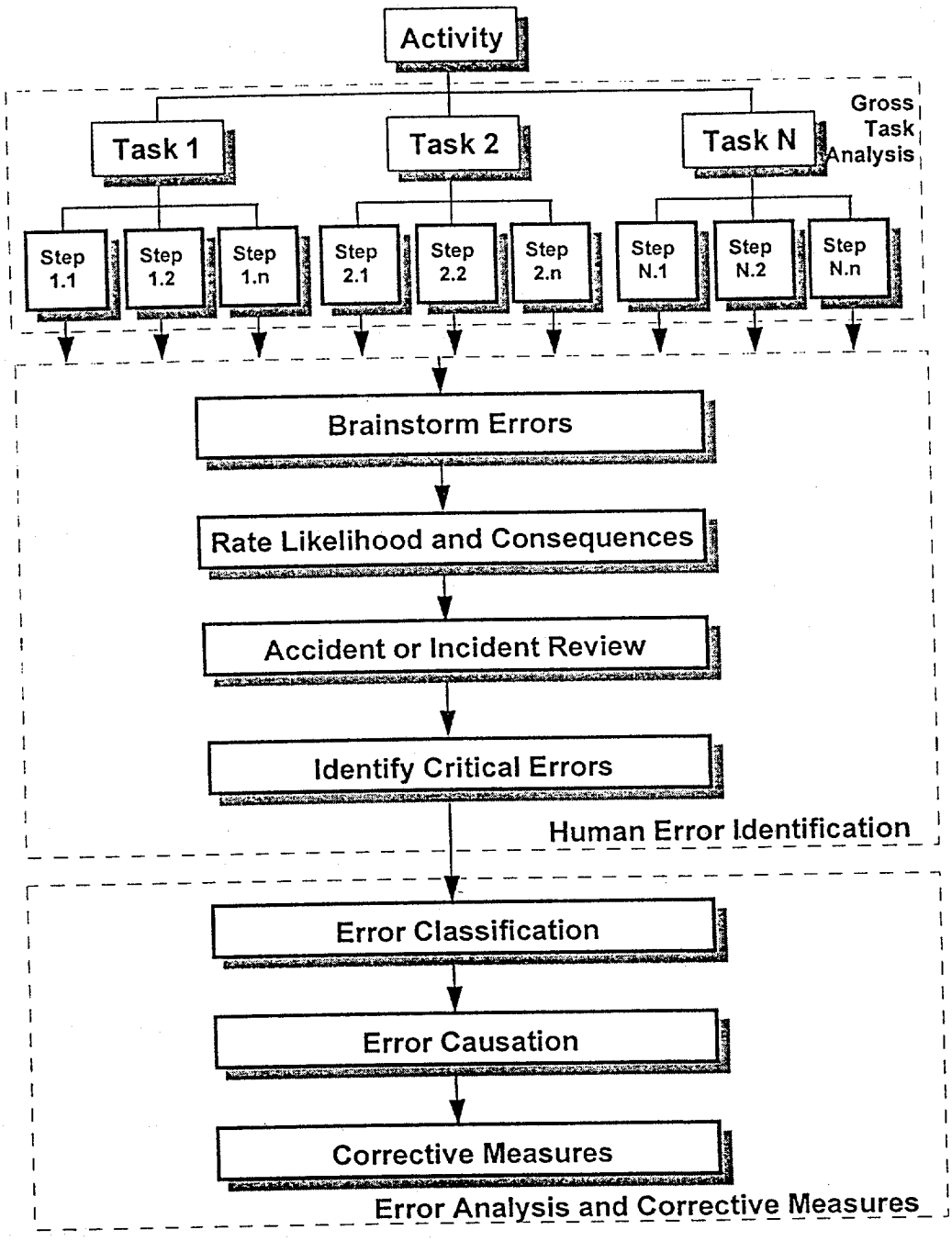
7. Which are the critical errors?

Error Analysis and Corrective Measures

8. What are the human factors cause(s) these errors?

9. What are some appropriate corrective measures?

An overview of the of the HEAT is presented below:


Activity
Task 1
Task 2
Task N
Gross Task Analysis
Step 1.1
Step 1.2
Step 1.n
Step 2.1
Step 2.2
Step 2.n
Step N.1
Step N.2
Step N.n
Brainstorm Errors
Rate Likelihood and Consequences
Accident or Incident Review
Identify Critical Errors
Human Error Identification
Error Classification
Error Causation
Corrective Measures
Error Analysis and Corrective Measures

GROSS TASK ANALYSIS

Gross Task Analysis is used to develop an outline of the procedure that is followed when conducting the activity under study. If detailed written procedures are available for the activity, the Gross Task Analysis is not necessary as the procedures can be used directly in Human Error Identification.

Gross Task Analysis involves the following steps

- Define the study scope
- Break the activity down into tasks
- Break each task down into the steps needed to perform the task

Define Study Scope

Defining the study scope involves setting the boundaries of the activity to be studied. This can be done by identifying the initial and final state of the system. For example, consider the following initial state:

- Cargo basket located on the deck of a service vessel
- Platform crane shut down with boom resting in the boom cradle

And the following final state:

- Cargo basket located on platform deck
- Platform crane shut down with boom resting in the boom cradle

Based on the above conditions, the activity to be studied could be described as "moving a cargo basket from the deck of a service vessel to the platform using the platform crane." Since the initial and final condition of the crane is that it is shut down with the boom resting in the boom cradle, the activity scope will include crane startup and shutdown.

GROSS TASK ANALYSIS

Tasks

Tasks are the individual functions necessary to accomplish an activity. Tasks can be performed by either a human or a machine, separately or in combination. They represent the first level of the procedural outline and should be stated in broad terms. Some examples of tasks in crane operation are:

- Position crane to a predetermined location
- Attach load
- Lift load
- Position load to a predetermined location
- Lower load
- Detach load

Steps

Steps are the actions necessary to complete a task. The process of identifying steps is analogous to that of identifying tasks. Examples of steps involved in positioning a crane to a predetermined location are:

- Select location to move crane
- Visually acquire location
- Operate crane controls to move/positions/lower crane

Gross Task Analysis Procedure

Resource Requirements

- An evaluation team of three or more people, at least one of whom is knowledgeable about the activity being analyzed.
- Job or task descriptive information such as written procedures, written training materials, training videos, etc.
- Meeting room
- Flip chart with colored writing pens
- White board with scanner (optional)

Preparation

If written procedures for the activity are available, these procedures can be used in lieu of the Gross Task Analysis. It may be appropriate to break procedures down into manageable tasks. This should be done by the team leader prior to holding the first team session. Copies of the existing procedure, broken down into the tasks, should be available for each team member.

Discuss the activity to be studied with evaluation team members or management personnel. Define the initial and final state of the system.

Record the activity description including the scope of the study on Form 1, "Human Error Assessment Summary."

Using the check list on Form 1, determine which information and other resources are necessary to conduct the study.

Obtain or generate the necessary information and resources prior to the initial evaluation team meeting.

If the written procedures are to be used in lieu of the Gross Task Analysis, generate a task list prior to the first team session.

Gross Task Analysis Procedure

Identify Tasks	Discuss the activity with the subject matter experts. Evaluation team members should ask questions and thoroughly discuss the activity so that everyone on the team has a good understanding of the activity.
	If possible, the evaluation team members should observe the activity being conducted. A simulation such as a training video can also be used to familiarize all team members with the activity.
	Using a flip chart or white board, list the major tasks associated with the activity in the sequence order that they are normally performed.
Identify Steps	Transfer the first task to a blank flip chart page.
	List the steps required to complete the task in the sequence order that they are normally performed.
	Continue in the above manner until a list of steps has been developed for each of the identified tasks.

HUMAN ERROR IDENTIFICATION

The objective of Human Error Identification is to identify critical human errors that can occur during the activity under study. A critical error is an error that has an associated high risk index, which is a combination of both the likelihood of error occurrence and severity of the error outcome.

Identifying critical errors is accomplished via several techniques:

- Brainstorm possible errors associated with each procedural step
- Rate the likelihood of error occurrence and the most likely consequence to obtain a base risk index.
- Verify and expand the error list by reviewing historical accident data or interviewing additional personnel.
- Modify the base risk index based on the findings of the accident review or personnel interviews.
- Compare the modified risk index to an arbitrary cutoff value. Critical errors are those with modified risk indices greater than the cutoff value.

Brainstorm Errors

Human errors are identified by examining the requirements of proper step performance and then generating a negative statement for the requirement. For example, if the step requirement is "open valve A by 1/2 turn"

A person could make several errors such as:

- Operator closes valve A by 1/2 turn
- Operator fails to adjust valve A
- Operator opens valve A by an excessive amount

Assign Risk Index	Once possible errors have been listed, the likelihood of making the error and the impact of making the error are rated. This rating process provides insight as to how tolerant a system is to error as well as how the system design (system being the hardware and organization support systems) influences error likelihood. Critical errors then become those errors that are: • Reasonably likely to occur • Not tolerated well by the system
Verify and Expand Error List	Brainstorming errors is subjective in that the results of the brainstorming session will be dependent on the knowledge and experience of the meeting participants. To ensure that error identification is as thorough as possible, the knowledge base can be expanded by: • Reviewing information on past accidents related to the activity • Interviewing additional personnel familiar with the routine performance of the activity Where accident data is available, reviewing this data is the most efficient way to verify the initial error identification. When such data is not available, interviewing 3-5 personnel that did not participate in the brainstorming will usually provide sufficient verification of the brainstorming results.

Modify Base Risk Index and Identify Critical Errors

The base risk index determined during the brainstorming is based on the likelihood and consequence ratings provided by the evaluation team. The accident data review or personnel interviews provide additional insight as to the likelihood and consequence of a given error.

To incorporate this new insight, the base risk index is modified by a factor that depends on the estimated frequency of occurrence during past operation. While this type of modification may not be appropriate for other types of hazard analysis, it is used here in order to more heavily weight system-induced errors which:

1. Are likely to happen
2. Can be reduced by modifying the system

Idiosyncratic errors, which are not system-induced, may account for a large number of the total errors that occur in a system. However, since these errors are more a function of the individual performing the activity, there will probably not be large clusters of the same error. System-induced errors, by definition, will occur with greater detectable frequency because they are an indication of a mis-match between human capabilities and the requirements of the system.

The risk index adjustment factor for each critical error is chosen based on the past frequency of occurrence for the error as follows:

1. Little or no previous accident or incident experience
2. Some previous accident or incident experience
3. Frequent previous accident or incident experience

Human Error Identification Procedure

Resource Requirements	• The evaluation team • Any available accident data for this activity • 3-5 personnel experienced in the activity (if interviews will be conducted) • Several copies of Form 2, "Gross Task Analysis and Error Identification"
Prepare Forms	For each task identified in the Gross Task Analysis, prepare one copy of Form 2, "Gross Task Analysis and Error Identification" by writing the task description in the appropriate location on the form.
Brainstorm Errors	Select a task. Enter the description of the first step under the subject Task in Column 1. Brainstorm human errors that can occur during the performance of the listed step. Enter each error into Column 2, one error per line.
Determine Risk Index	For each identified error, assign a rating for the likelihood of error occurrence in Column 3. The likelihood scale ranges from 1 to 5, with 1 being low likelihood and 5 being high likelihood.

Enter a rating for the consequence of the error in Column 4. The consequence ratings range from 1 to 5 and have the following meaning:

1. Operational delays
2. Equipment damage
3. Injuries and/or major equipment damage
4. Severe injury fatality
5. Catastrophic event with possible multiple fatalities

Calculate the base risk index by multiplying the likelihood rating (Column 3) by the consequence rating (Column 4). Enter the result in Column 5.

When all errors identified for this step have been assigned a risk index, proceed to the next step for this task.

When all steps for this task have been reviewed, proceed to the next task.

Accident Data Review

For each accident record, determine which of the previously identified errors was involved in the accident.

If a human error that was not previously identified was involved in the accident, add the error description into the proper location on Form 2.

Count the number of times each error was involved in an accident.

	Assign a risk index adjustment factor to each error based on the following scale: 1. Little or no previous accident experience 2. Some previous accident experience 3. Frequent previous accident experience
	Enter the adjustment factor in Column 6.
	Calculate the modified risk index for each error by multiplying the value in Column 5 by that in Column 6. Enter the result in Column 7.
Personnel Interviews	Using the interview guideline questions provided in Table 1, interview personnel regarding their past involvement with the activity. The goal of the interview is to determine the types of errors that people frequently make when performing the activity, regardless of whether the error resulted in an accident. These errors may have resulted in "near miss" incidents that were not formally documented.
	If a human error that was not previously identified was involved in the incident, add the error description into the proper location on Form 2.
	Count the number of times each error was involved in an incident or was brought up by interviewees.

	Assign a risk index adjustment factor to each error based on the following scale: 1. Little or no previous incident experience 2. Some previous incident experience 3. Frequent previous incident experience
	Enter the adjustment factor in Column 6.
	Calculate the modified risk index for each error by multiplying the value in Column 5 by that in Column 6. Enter the result in Column 7.
Identify Critical Errors	Review the modified risk index for each of the identified errors. If the modified risk index is 12 or more, classify the error as critical and review it using the Error Analysis and Corrective Measures Procedures.

Information Processing Model

The ultimate goal of the HEAT is to identify possible corrective measures for system-induced human errors. In order to develop effective corrective measures, specific causes of these errors must be understood.

In order for a person to successfully interface with a machine or processing system, the following must occur:

- The information required to prompt the operator to take an action must be available at detectable levels.
- The required information must be accurately received by the operator within the required time frame for action.
- The operator must interpret the information and choose the correct response.
- The operator must properly manipulate the machine or process to implement the correct response.

An information processing model can be used to classify human errors into the following categories that correspond to the above bullets:

- Information source errors
- Information reception errors
- Decision/response errors
- Action errors

Information Source	Information sources provide data that the operator must receive in order to take appropriate action. Information sources can include both direct information from • the machine • an object • a signal person, or indirect information provided by • visual displays • auditory displays, etc.
Information Reception	Information reception includes both the transmission mode for the information as well as how the operator perceives the information. Transmission mode may include such items as line-of-sight to the information, background noise (when the information source is auditory), communication systems such as telephone or two-way radio, etc. Operator perception is via one or more of the five senses: sight, hearing, touch, smell, and taste.
Decision/ Response	Decision/response includes interpretation of the information based on memory, skills, attention, and higher level reasoning skills. It also involves selecting the correct response to the information based on all of the above.
Action	Action is the controlled movement of muscles to manipulate controls and affect the proper change to the system.

Error Classification

To better understand the causes of error, the error is classified based on the information processing model. The Error Classification Matrix in Table 2 relates the manifestation of an error (no action, late action, wrong action) to the information processing model via descriptive text. For example, if a person does not take required action, if may be for one or more of several reasons:

- The information needed to prompt the action is not available.
- The person does not receive the information due to a physiological limitation (receptor limitation) or an environmental disturbance that prevents or disrupts information transmission from the source to the receptor.
- The person ignores or mis-interprets information and, as a result, does not recognize the need for action.
- The person receiving the information does not have the ability or skill to perform the required action.

The value of error classification ultimately lies in identification of corrective measures designed to correct the faulty stage of information processing, thus eliminating the system-induced cause of error.

Error Causation

The Corrective Measures Matrix (Table 3) provides guidelines for developing corrective measures based on the error classification. The corrective measures suggested in this matrix are generic and must be considered in light of the specific activity under study.

A human error can result from one or more system-related causes. However, it is common that overall error occurrence is dominated by relatively few specific causes. As a result, it may not be necessary, or appropriate, to equally weigh each identified cause of error.

To focus resources on those causes that dominate error occurrence frequency, the HEAT requires the evaluation team to rate the likelihood of occurrence for each specific cause. Although it may be possible to suggest corrective measures for each cause, the greatest benefit toward error control will be achieved by focusing on high likelihood causes. The cutoff suggested by the JIP is to focus on causes with a likelihood rating of 3-5.

Resource Requirements	• The evaluation team • All or the previously completed forms • Form 3, "Error Analysis and Corrective Measures" • Error Classification Matrix (Table 2) • Corrective Measures Matrix (Table 3)
Prepare Forms	Prepare Form 3, "Error Analysis and Corrective Measures," for each of the identified critical errors. Include the task in which the error occurs, the step in which the error occurs, a description of the error, and the modified risk index for the error.
Classify Errors per HF Model	Classify the errors according to the information processing model using the Error Classification Matrix (Table 2) on Form 3. Check all boxes in this matrix that apply to the identified error.
Identify Causes of Error	For each box checked in the error classification matrix, list the possible causes of the error on the bottom section of Form 3. Attach additional forms if necessary.
Rate Likelihood	Rate the likelihood that each specific cause will result in the error of concern. The likelihood ranges from a low of 1 to a high of 5.
Suggest Corrective Measures	Suggest appropriate corrective measures for each cause that is assigned a likelihood rating of 3, 4, or 5. The Corrective Measures Matrix (Table 3) provides guidelines for appropriate corrective measures based on the error classification. Corrective measures, whenever possible, should focus on correcting the cause of the error.
	Note any comments related to the cause or suggested corrective measure.

Table 1

PERSONNEL INTERVIEW GUIDELINES

Critical Incident Questions

1. Can you think of a situation in which an accident occurred or almost occurred while performing this task?
2. What were the general circumstances leading up to this incident?
3. How often has this occurred?
4. Was there some action or inaction by the people involved that contributed to the incident?
5. When did this occur?
6. What was your role in the activity?
7. How long have you been performing this task?
8. What needs to be done to prevent this type of accident?
9. What would you do if this type of accident occurred?
10. Other comments?

Table 2: ERROR CLASSIFICATION MATRIX

Information Processing Stage	Description of Stage	Information Processing Mechanisms	Type of Error		
			No Action	Late Action	Wrong Action
Information Source	Information provide data that the operator must receive in order to take appropriate action	Direct information from: Machine, object or person (sight, sound, movement, temp, smell, pressure, vibration) Indirect: Visual displays (gage, dial, lights, knob position) Auditory displays (sirens, horns)	Sources Information not present or not detectable (below human sensory threshold)	Source information not present at right time	Source information incorrect
Information Reception	Source information must be received by accomplished by specialized human sensory mechanisms • Transmission of information from the information sources to the human receptor • Proper reception of the information by the receptor	Sense: Vision - color, hue brightness, line-of-sight Sound - pitch, loudness Touch - vibration, temp, pressure Smell, Taste, Body Position, and Movement	Information cannot be received by specific operator (deaf, color blind) Information cannot be received because of environmental conditions (noise, darkness, brightness, weather)	Information delayed because of difficulties in reception	Incomplete reception because of distortion, disruption or distraction
Decision/ Response	Information received is used to invoke rules of reasoning in order to select a response	Attention (determining which information received is important) Memory (of learned rules and experience) Comparison (of received information with expected) Response generation (selecting response and action sequence)	Information not attended to (distracted, fatigue) Information ignored (not considered important) Not aware of correct response (faulty learning or experience)	Delays in processing (high workload, fatigue, stress, physiological condition)	Selects wrong action (incomplete learning or experience) Selects wrong control device
Action	Controlled movement of muscles to effect a change in the machine or process	Ability (action in within the capability of individual) Skill (training and practice to perform action successfully) Endurance (can sustain action)	Action not within ability	Slow to act (lack of practice of experience)	Wrong sequence - timing errors (lack of skill) Cannot sustain action (lack of endurance)

Table 3: CORRECTIVE MEASURES MATRIX

Information Processing Stage	Type of Error	Possible Corrective Measure(s)
	No Action (E1)	
Information Source	1 Source information not present or not detectable (below human sensory threshold)	1 Provide information above detection threshold
Information Reception	2 Information cannot be received by specific operator (deaf, color blind)	2 Define required personnel attributes in fitness testing
	3 Information cannot be received because of environmental conditions (noise, darkness, brightness, weather)	3 Control environment; seek another sensory receptor; make information redundant (more than one source)
Decision/Response	4 Information not attended to (distracted, fatigue)	4 Reduce workload; improve rest cycles or shift pattern; provide pre-alerting signal before vital information is presented
	5 Information ignored (not considered important)	5 Procedural training and supervision. Mandatory checkpoints - flag removal
	6 Not aware of correct response (faulty learning or experience)	6 Training and practice
Action	7 Action not within ability	7 Define required personnel attributes; fitness testing
	Late Action (E2)	
Information Source	8 Source information not present at right time	8 Improve information flow or communications. Improve task sequencing.
Information Reception	9 Information delayed because of difficulties in reception	9 Improve source intensity; reduce background interference
Decision/Response	10 Delays in processing (high workload, fatigue, stress, physiological condition)	10 Reduce workload; improve rest cycles or shift pattern; provide pre-alerting signal before vital information is presented; increase supervision
Action	11 Slow to act (Lack of practice or experience)	11 Improve skills with "hands-on" training or frequent drills
	Wrong Action (E3)	
Information Sources	12 Source information incorrect	12 Provide correct information
Information Response	13 Incompletely processed because of distortion, disruption, or distraction	13 Reduce demands of competing tasks; improve communications system; provide training for information priority
Decision/Response	14 Select wrong action (Incomplete learning or experience)	14 Improve training; conduct frequent drills
	15 Selects wrong control device	15 Modify the control display or configuration to improve differentiation
Action	16 Wrong sequence - timing errors (Lack of skills)	16 Improve control sequence identification; conduct frequent drills
	17 Cannot sustain action (Lack of endurance)	17 Define required personnel attributes; fitness testing; improve training; redesign job

Form 1: HUMAN ERROR ASSESSMENT SUMMARY

Study Scope

Describe the State(s) of System Prior to Conducting the Activity:

Describe the State(s) of the System at Completion of the Activity:

From the Above, Create a Concise Statement of Scope for this Human Error Assessment:

Evaluation Team

List the Names and Titles of the Evaluation Team Members. Circle the Name of the Evaluation Team Leader

Study Preparation Checklist

The following checklist can be used for study planning purposes. Check off items needed for the study and obtain before the first evaluation team meeting

Item	Required?	Arranged
Team members	☐	☐
Written Procedures	☐	☐
Training Materials	☐	☐
_____	☐	☐
_____	☐	☐
_____	☐	☐
Meeting Room	☐	☐
Flip Chart w/ Pens	☐	☐
White board w/ Scanner	☐	☐

Item	Required	Arranged
Copies of Blank Heat Forms	☐	☐
Accident Data for the Activity	☐	☐
Access to Personnel for Interviews	☐	☐
Interview Guideline Questions (Table 1)	☐	☐
Error Classification Matrix	☐	☐
Corrective Measures Matrix	☐	☐

Form 2: GROSS TASK ANALYSIS AND ERROR IDENTIFICATION

Activity: _____ Date: _____

Task Number and Name: _____

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Step Number and Name	Human Error Description	Likelihood of Error* (1-5)	Consequence of Error** (1-5)	Risk Index (3) * (4)	Adjustment Factor***	Modified Risk Index (5) * (6)
_____._____						
_____._____						
_____._____						
_____._____						

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High

** Consequence of Errors: 1 - Operational delays; 2 - Equipment Damage; 3 - Injuries and Major Equipment Damage; 4 - Death, Severe Injuries; 5 - Multiple Fatalities

*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents

**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 3: ERROR ANALYSIS AND CORRECTIVE MEASURES

Activity: _____ Date: _____

Task Number and Description: _____

Step Number and Description: _____

Error Description: _____

Errors by Information Processing Stage
Check all that apply

Stage / Error	Information Source	Information Reception	Decision/Response	Output Action	Comments
No Action	1 ☐ Not present or below threshold	2 ☐ Operator limitation 3 ☐ Environmental interference	4 ☐ Inattention 5 ☐ Information ignored 6 ☐ Unaware of correct response	7 ☐ Lack of ability	
Late Action	8 ☐ Late availability	9 ☐ Delayed reception	10 ☐ Delays in processing	11 ☐ Delayed action	
Wrong Action	12 ☐ Incorrect information	13 ☐ Incorrect of incomplete reception	14 ☐ Selects wrong action 15 ☐ Selects wrong control device	16 ☐ Wrong sequence 17 ☐ Action not sustained or incomplete	

Cause of Error From Above	Likelihood of Cause Low Medium High	Possible Corrective Action (See Table)	Comments
	1 2 3 4 5		
	1 2 3 4 5		
	1 2 3 4 5		
	1 2 3 4 5		